Mission Restoration Project

Fuels & FireBehavior Resource Report

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for:
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Okanogan-Wenatchee National Forest

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Regulatory Framework

The project area encompasses the Buttermilk Creek and Libby Creek sub-watersheds. Approximately 96% of this area is within National Forest System (NFS) lands and is covered by this analysis.

Land and Resource Management Plan

The OkanoganNational Forest Land and Resource Management Plan (LRMP; USDA 1989) provides standards and guidelines for fuels and fire management in this project area. The forest-wide standards

and guidelines specific to fuels management are listed below, followed by the management areas within the project boundary and their respective standards and guidelines related to fuels management.

Forest-wide Standards and Guidelines

- **19-4:** Prescribed fire (planned and unplanned ignitions) may be used as a management tool to meet Management Area goals.
- **19-6:** Cost-effective fuel treatment methods shall be used to achieve management goals. The desired fuel profile and fuel treatments necessary to achieve that profile shall be determined. Treatment methods shall be selected based upon appropriate analysis, which includes long-term site productivity considerations, for all management activities or where natural fuel accumulations create a fuel profile that poses an unacceptable impediment to current or future protection and management.
- **19-7:** Woody debris shall be left on the forest floor for wildlife habitat, long-term site productivity, soil fertility, and, where necessary, for microsite protection and seed. A sufficient amount of this debris shall be uncharred to provide for terrestrial wildlife, long-term soil productivity, and other purposes.
- **19-8:** Treatment of natural fuels shall be prohibited in identified old growth stands.
- **19-9:** In stands managed as future old growth, fuels treatment including prescribed fire shall provide for the retention of all key components of old growth.
- **20-1:** When practicable, accomplish site preparation objectives concurrently with fuels management objectives.
- **20-26:** Where planting is prescribed, site preparation should be completed within two years following harvest. Firewood availability shall be considered in site preparation planning.
- **20-49:** To the extent practicable, fuel treatments following precommercial thinning and commercial thinning should minimize damage to residual stems. Crop tree stocking shall not be reduced below prescribed minimum levels by fuel treatments.

Management AreaStandards and Guidelines

Management Area 5 (11% of the project area): the LRMP Goal is to provide opportunities for recreation and viewing scenery in a roaded natural setting with a visual quality objective of retention or partial retention. Standards and Guidelines for Fire and Fuels are:

- **MA5-19C:** Use of prescribed fire should meet the visual quality objective within three years of application.
- **MA5-19D:** Recreation, visual, and wildlife values shall be key considerations in determining overall fuel treatment levels and methods.

Management Area 14 (22% of the project area): the LRMP goal is to provide a diversity of wildlife habitat, including deer winter range, while growing and producing merchantable wood fiber. Standards and Guidelines for Fire and Fuels are:

- **MA14-19C:** Treat fuels to reduce the risk of wildfire to acceptable levels. Prescribe a level of fuel treatment to protect timber stands, wildlife values, and other resources from unacceptable losses caused by wildfire.
- **MA14-19D:** Place fire-tolerant stands on a prescribed burning schedule where cost-effective to meet management goals.

Management Area 15B (31% of the project area): the LRMP goal is to maintain a predominately unmodified primitive environment within designated wilderness with a variety of trail opportunities. Standards and guidelines for fuels management are:

- **MA15B-19C:**Planned ignition shall not be used to initiate prescribed fire in wilderness areas.
- **MA15B-19D:** Prescribed fire ignited by lightning may be used to meet wilderness fire management objectives of: 1) reducing the risks and consequences of wildfire within the wilderness or escaping from the wilderness, and 2) permitting lightning-caused fires to play, as nearly as possible, their natural ecological role within wilderness.
- **MA15B-19E:** A prescribed fire plan shall be approved prior to the use of prescribed fire in the wilderness.

Management Area 17 (less than 1% of the project area): the LRMP goal is to provide a variety of developed recreation opportunities in a roaded setting (in this case, Blackpine Lake Campground). Standards and guidelines for fuels management are:

- **MA14-19C:** Fuels shall be treated to meet visual and recreation objectives and to eliminate, to the maximum extent possible, the probability of a wildfire that will damage the recreation resource.

Management Area 25 (30% of the project area): the LRMP goal is to intensively manage the timber and range resources using both even-aged and uneven-aged silvicultural practices. Manage to achieve a high present net value and a high level of timber and range outputs while protecting the basic productivity of the land and providing for the production of wildlife, recreation opportunities, and other resources. Standards and guidelines for fuels management are:

- **MA25-19C:** Treat fuels to reduce risk of wildfire to acceptable levels while maintaining long-term site productivity.
- **MA25-19D:**Prescribe a level of treatment for natural and activity created fuels to protect timber stands and other resources from unacceptable losses caused by wildfire.
- **MA25-19E:** Place fire tolerant stands on a prescribed burning schedule where cost effective to meet management and objectives.

Management Area 26 (2% of the project area): the LRMP goal is to manage deer winter range and fawning habitats to provide conditions which can sustain optimal numbers of deer indefinitely, without degrading habitat characteristics such as forage, cover, and soil. Standards and guidelines for fuels management are:

- **MA26-19C:** Fuels treatments, including the use of prescribed fire, shall provide, where practicable, for the retention and/or enhancement of key wildlife habitat.

Northwest Forest Plan

In 1994, the LRMP was amended by the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl (hereafter referred to as the Northwest Forest Plan, or NWFP) (USDA and USDI 1994). The NWFPcreatedadditional management designations that overlap the LRMP management areas described above. Some NWFP designations overlap others, therefore the total percentage of lands within NWFP designations will exceed 100%. The standards and guidelines from Okanogan LRMP apply where they are more restrictive or provide greater benefits to late successional forest-related species than other provisions of these standards and guidelines. The NWFP management areas and standards and guidelines related to fuels management in the project area are listed below.

Congressionally Reserved: This designation covers 31% of the project area and lies completely within LRMP MA15B, the Lake Chelan-Sawtooth Wilderness. The NWFP does not describe any specific standards or guidelines for fuels management in Congressionally Reserved areas.

Riparian Reserves: Riparian Reserves (RRs) cover10% of the project area and overlapportions of all other land management designations in this project area. RRs provide areas along all streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis.RR standards and guidelines for fuels management are:

- **FM-1:** Design fuel treatment strategies, practices, and activities to meetAquatic Conservation Strategy objectives, and to minimize disturbance of riparian groundcover and vegetation. Strategies should recognize the role of fire in ecosystem function andidentify those instances where fuels management activities could bedamaging to long-term ecosystem function.

- **FM-4:** Design prescribed burn projects and prescriptions to contribute to attainment ofAquatic Conservation Strategy objectives.

- **FM-5:** Immediately establish an emergency team to develop a rehabilitation treatment planneeded to attain Aquatic Conservation Strategy objectives whenever Riparian Reserves aresignificantly damaged by a prescribed fire burning outside prescribed parameters.

- **Other:**In Riparian Reserves, water drafting sites should be located andmanaged to minimize adverse effects on riparian habitat and water quality, as consistentwith Aquatic Conservation Strategy objectives.

Late Successional Reserves (LSRs): Two LSRs cover 5% of the project area and lie within LRMP MA 5 (106 acres of the Twisp River LSR) and MA25 (2338 acres of the Sawtooth LSR).NFWP objectives for LSRs include managing these areas to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth related species including the northern spotted owl. These reserves are designed to maintain a functional, interacting, late-successional and old-growth forest ecosystem.Fuels management in LSRs will use minimum impact suppression methods in accordance with guidelines forreducing risks of large-scale disturbances.

Matrix: This designation covers 60% of the project area and lies within LRMP MA 5 (5250 acres), MA14 (10,979 acres), MA17 (38 acres), MA25 (12,486 acres) and MA 26 (1163 acres).NWFP objectives for Matrixallow for timber harvest and other silvicultural activities in suitable forest lands.Standards and guidelines for fire and fuels management in Matrix recommend that where this designation lies in the rural interface, fire management activities should be coordinated with local governments, agencies, and landowners during watershed analysis to identify additional factors which may affect hazard reduction goals.

Special Area Designations

Sawtooth Inventoried Roadless Area

The project area contains approximately 3300 acres of the Sawtooth Inventoried Roadless Area (IRA). Proposed prescribed fire and associated fireline are proposed in this area and may occur as long as they do not degrade the roadless character of the area. The effects of these proposed treatments are disclosed in the Recreation-Scenic Resources report.

Manual Direction

Forest Service Manual 5100 –Fire Management Policy(USDA 2012a)

Forest Service Manual (FSM) direction regarding fire management activities is authorized and guided by multiple federal laws (FSM 5101.1) that are incorporated here by reference. FSM 5100 policy relevant to this analysisis as follows:

FSM 5103.2 Ecological

1. Identify and use fire ecology to frame land and resource management objectives.
2. Use Fire Management programs and activities to implement Land and Resource Management Plans objectives.
3. Incorporate public health and environmental quality considerations into fire management programs and activities.
4. Manage the land to make it more resilient to disturbance, in accordance with management objectives

Forest Service Manual Chapter 5140 – Hazardous Fuels Management and Prescribed Fire (USDA 2014)

This sub-chapter of FSM 5100 provides direction on mitigating hazardous fuels and using fire to achieve desired landscape conditions and attain LRMP objectives. FSM 5140 policy relevant to this analysis includes:

FSM 5140.3 Policy

Plan and implement a hazardous fuels management and prescribed fire program applying:

1. Principles and policy elements described in FSM 5103 and Wildland Fire Doctrine (FS 5131).
2. Principles from the Cohesive Strategy (A National Cohesive Wildland Fire Management Strategy Phase II National Report, May 2012) (Wildland Fire Leadership Council; 2012).
3. Guidelines from the Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide (NWCG 2014).
4. Consideration of greenhouse gas emissions and effects on carbon sequestration.

FSM 5141 Hazardous Fuels Management and Prescribed Fire Planning

1. Overall direction for hazardous fuels management and prescribed fire is provided by the LRMP, which serves as the document to initiate, analyze, and provide the basis for implementing hazardous fuels management and prescribed fire projects to meet resource management objectives.
2. The broad direction for implementing the hazardous fuels management and prescribed fire program is documented in the Fire Management Reference System.
3. Resource objectives for specific hazardous fuels management and prescribed fire projects are derived from the NEPA analysis. The entire project area must be analyzed under NEPA. The NEPA analysis document (EIS, EA, or CE) will be used to identify objectives and analyze the effects of hazardous fuels management and prescribed fire projects.

FSM 5142.3 – Prescribed Fire Policy

1. When appropriate, use prescribed fire in a safe, carefully planned, and cost-effective manner to achieve desired conditions and attain management objectives identified in the LRMP.
2. The National Wildfire Coordinating Group (NWCG) Interagency Prescribed Fire Planning and Implementation Procedures Guide – PMS 484 (NWCG 2014) is Forest Service policy.
3. Declared wildfires will be reviewed using FSM 5137.1 and guidelines from the Interagency Prescribed Fire Planning and Implementation Procedures Guide – PMS 484 (NWCG 2014).
4. Weather conditions must be monitored during all phases (including mop-up) of prescribed fire implementation.
    a. Long-term weather conditions such as drought must be considered in all phases of prescribed fire planning and implementation.

b. A project-specific spot weather forecast must be obtained prior to ignition; for each day that ignition continues; on any day the fire is actively spreading; or when conditions adversely affecting the prescribed fire are predicted in the general forecast.

c. The authorizing Line Officer may make an exemption from the spot weather forecast requirement using specific criteria listed in FSM 5142.3 (4)(c).

Watershed Analyses

Twisp River Watershed Analysis (USDA 1995a):

This analysis covers the Buttermilk Creek portion of the Mission project area and notes that the trend in species change from ponderosa pine to Douglas-fir is expected to continue if management practices remain the same. Suppression effectiveness would remain the same until fuel accumulation increases to more critical levels; given the right weather and an increase in dead surface fuels, future fires would be high severity and very difficult to suppress. Emissions from wildfire would increase and air stagnation episodes would occur more frequently during summer recreation periods as most critical fire weather occurs during periods of stable high pressure which also stagnates the air. Forest health would also deteriorate as insects and diseases continue to attack overstocked Douglas-fir stands. Future management would need an aggressive prescribed fire program to begin to re-establish the influence of fire on the ecosystem.

Libby Creek Watershed Analysis (USDA 1995b) and Lower Methow Watershed Analysis (USDA 1999):

These analyses cover the Libby Creek portion of the Mission project area. Recommendations associated with fire and fuels management relevant to this project include:

- Continue the program of working with landowners to implement prescribed fire in the watershed.
- Identify and maintain areas in the watershed that are natural fuelbreaks.
- Survey the watershed for additional fuelbreak opportunities especially in regard to LSR areas.
- Manage the watershed so that high severity fire affects are minimized, i.e. implement thinning prescribed burn projects or other means of restoring historical fire return intervals.
- Manage fuel in Libby Creekso that high-severity fire events do not degrade large areas and destroy habitat for proposed threatened or endangered fish species.
- Libby Creek should be managed to develop park-like ponderosa pine character on southerly aspects, with areas of an all-age mosaic of Douglas-fir and lodgepole on northerly aspects. To maintain stand health and minimize potential for stand-replacement fires, thinning, underburning, and mistletoe sanitation should be the primary treatments.

- Focus silviculture and prescribed burning on boundary lands to create fuelbreaks to reduce risk of fire spread from National Forest System (NFS) land to private and vice versa. Focus on Smith Canyon, Alder Creek, Elderberry Canyon, Chicamun Canyon, and Lower Libby Creek.

Other Guidance or Recommendations

Federal Wildland Fire Management Policy

Federal wildland fire management policy (Fire Management Policy, or FMP) described in the *Review and Update of the 1995 Federal Wildland Fire Management Policy* (USDOI et al. 2001) is implemented through*Guidance for Implementation of Federal Wildland Fire Management Policy* (USDA & USDOI, 2009),*Cohesive Fuels Treatment Strategy* (USDI and USDA, 2006) and the *National Cohesive Wildland Fire Management Strategy Phase II*(USDI and USDA, 2006) *and Phase III*(USDA & USDI, 2014). Policies direct land managers to consider wildland fire as an essential ecological process and natural change agent that will be incorporated into the LRMP and project-level planning processes. At project-level planning (such as that underway in the Mission Restoration project), policy directs that fire management activities (including vegetation treatments) focus on reducing hazardous fuels and restoring fire-adapted ecosystems using a planning and decision analysis processes that address current and anticipated conditions.

Okanogan-Wenatchee Forest Restoration Strategy

The Okanogan-Wenatchee Forest Restoration Strategy (Restoration Strategy) (USDA 2012b) was developed to provide land managers with the ability to efficiently examine broad Forest landscapes, allowing managers to select high priority areas, design integrated restoration treatments, and consider historical and potential future reference conditions under different climate scenarios (ibid). Forest direction mandates use of the peer-reviewed Restoration Strategy in analyzing conditions in the Mission project area and developing possible treatment options to respond to findings. The Restoration Strategy is consistent with FSM 2020 (Ecological Restoration and Resilience) because it provides the means to re-establish and retain ecological resilience of National Forest System lands and associated resources to achieve sustainable management and provide a broad range of ecosystem services. Resilience is defined as the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes. A resilient ecosystem can withstand shocks and rebuild itself when necessary (Walker et al. 2004). Healthy, resilient landscapes will have greater capacity to survive natural disturbances and large-scale threats to sustainability, especially under changing and uncertain future environmental conditions, such as those driven by climate change and increasing human use.

Spruce Budworm Assessment

The Methow Valley Ranger District was assessed for impacts by western spruce budworm (WSB) (*Choristoneura occidentalis*) activity, resulting in the development of several recommendations for consideration in project-scale planning (USDA 2012c). Recommendations applicable to fuels management planning in this project include:

- Focus silvicultural and prescribed fire treatments in the dry-cover types to reduce susceptibility to western spruce budworm and reduce risk of uncharacteristic crown fires. Given the scope of the problem, implement the Forest Restoration Strategy at the 5th field watershed level.
- Implement a District-wide fuelbreak and road treatment strategy to provide additional time for silvicultural and fuels treatments to occur.

Okanogan County Community Wildfire Protection Plan

The Okanogan County Community Wildfire Protection Plan (CWPP) (Bloch et al. 2013a, 2013b) was collaboratively developed by local and state government representatives in consultation with federal agencies and other interested parties, and was last updated in 2012. The CWPP incorporates and supersedes the Methow Community Wildfire Protection Plan, using local interagency and public input to create a plan-specific definition of Wildland Urban Interface (WUI)that considers risks to developments within fire-prone environments in Okanogan County. As participants in the CWPP, local federal land management planning agencies use the CWPP delineation of WUI and consider the CWPP's recommendations for priority treatment areas during project planning efforts.This project will also use the CWPP delineation of WUI.

National Roadmap for Responding to Climate Change

This document provides guidance for National Forests to adapt and prepare for changing climates, with a management emphasis on restoring the functions and processes characteristic of healthy, resilient ecosystems through adaptive restoration. The Roadmap identifies the connection between restoration and developing the ability of ecosystems to withstand the stresses and uncertainties associated with climate change (USDA 2010).

Affected Environmentand Environmental Consequences

Resource Indicators and Measures

Figure 1 describes the fuels and fire resource indicators that will be used to evaluate existing conditions in this project area and effects of proposed treatments.

Figure 1:Resource Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure (Quantify if possible)	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Restoration or maintenance of fire behavior to within the desired range of variability.	The amount and arrangement of each type of crown fire risk as compared to the desired range of variability.	Percentage of Libby and Buttermilk landscapes in Low, Moderate, & High risk of crown fire	P&N #1 P&N #3 P&N #4	LRMP S&G NWFP S&G FSM Restoration StrategyFMP

Resource Element	Resource Indicator	Measure (Quantify if possible)	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
		Average patch size (in acres) of Libby and Buttermilk landscapes in Low, Moderate, and High risk of crown fire		
Wildfire hazard in Wildland Urban Interface	Fire behavior in WUI	Percent of flame length by size class	P&N #6	LRMP S&G NWFP S&G FSM FMP CWPP
		Percent of fire behavior by type (none, surface, crown)		
	Fire behavioralongFS Roads 43 and 4340	Percent of flame length by size class		
		Percent of fire behavior by type		
Access for vegetation and fire management	Roads in project area	Percent of FS roads greater than ½ mile in length that would remain or be decommissioned.	P&N #7	LRMP S&G

Methodology

The methodologies used to analyze resource indicators are described below. Modeling results were interpreted using more than twenty-five years of local prescribed burning and fire suppression experience gained in similar terrain, fuel types, fuel loading, stand composition, and weather conditions.

Resource Indicators: The amount and arrangement of each type of crown fire risk in the Buttermilk and Libby Creek watersheds as compared to the desired level between historical and future ranges of variability.

The Restoration Strategy (Reynolds 2002; Reynolds et al. 2003; USDA 2012b) outlines the analysis process used to evaluate landscape conditions and assess whether landscape characteristics such as crown fire risk have departed fromhistoric and/or future ranges of variability. The process involves conducting photo interpretation to identify multiple vegetation and landscape attributes in each of the two sub-watersheds in the project area: Buttermilk Creek and Libby Creek. The Ecosystem Management

Decision Support (EMDS) modeling tool(EMDS 3.0.2, ibid) used these data to evaluate existing landscape and stand-level characteristicsand trends separately foreach sub-watershed. EMDS was used to compare the current conditions to a range of historicaland future reference conditions for each sub-watershed to give insights into how vegetation and disturbance systems have changed and how they are likely to change over time.

In this analysis, crown fire risk (CFR) at low, moderate, and high levels (Appendix C in Huff et al. 1995) is the primary fire characteristic used to assess how fire behavior has changed from 80th percentilevalues for the historical range of variability (HRV)and the future range of variability (FRV). HRV refers to the fluctuations in ecosystem composition, structure, and process over time, especially prior to the influence of Euro-American settlers (USDA Forest Service 2012b). FRV refers to expected fluctuations in these elements due to projected changes in climate (ibid). Crown fire risk describes the potential for a surface fire to transition into a crown fire, which increases fire severity (the effect of a fire on ecosystem properties, usually defined by the degree of soil heating or mortality of vegetationas indicated by vegetation mortality, habitat alteration, and other fire effects (Agee 1993).

CFR naturally exists at various levels in forest vegetation in the project area, and is influenced by vegetation structure, number of canopy layers, crown cover, weather, and surface fire behavior such as flame length (Huff et al. 1995). Vegetation characteristics in turn are influenced by temperature and moisture regimes. From a management perspective, changes in the type, amount, and arrangement of crown fire risk on the landscape may cause concern because some of the conditions that increase CFR (i.e. greater flame length, and denser, multi-level stands) contribute to uncharacteristic fire effects, more severe air quality degradation, greater difficulty in controlling a wildfire, and higher risk of stand-replacement wildfiresin areas that did not usually experience this type of disturbance (ibid). Uncharacteristic fire behavior in this analysis is defined as fire frequency and effects in a given landscape that are departed from the historical natural fire regime's range for that landscape (Hardy et al. 1998). A historical natural fire regime is a description of the frequency and impacts of historical fire conditions under which vegetation communities evolved and were maintained without fire exclusion(Hardy 2005).

EMDS was used to classify CFR into low, moderate, and high levels in each sub-watershed. Each level of CFR was measured by the percentage of land to indicate the overall amount on the landscape, and by average patch size to indicate the arrangement of this fire behavior on the landscape. Patch size is a landscape ecology term defined as a relatively homogeneous area that differs from its surroundings; patches are the basic unit of the landscape that change and fluctuate through a process called patch dynamics (*https://en.wikipedia.org/wiki/Landscape_**ecology**, accessed 10/20/16).*HRV was determined by analyzing an ecosystem sub-regions (ESR) composed of similar climate, geology, topography, aquatic characteristics, and disturbance historiesto the respective sub-watersheds in the project area(Huff et al. 1995; Hessberg et al. 1999; USDA 2012b). The future range of variability (FRV) was developed to provide insight as to how the sub-watersheds may be affected by changing climate. EMDS was used to model an ecosystem with landscape characteristics in the next warmer ESRthan each sub-watershed as a conservative proxy for reference conditions under climate change (USDA 2012b). These outcomes are used in this analysis as the FRV.Because EMDS used a conservative approach in estimating climate change, it may underestimate the FRV if the degree of climate change is more severe than indicated by the next warmer ESR.

The desired values for CFR at each level were determined by finding where the HRV and FRV overlap; this intersection is called “the desired range of variability” in this analysis. The landscape prescription for CFR was developed based on the need to maintain this fire behavior characteristic within this intersecting range, or to move this characteristic closer towards the intersecting range where it is outside of this value. Potential treatmentswere developed to alter the conditions that affect CFR, including prescribed fire and thinning, while recognizing that terrain and weather (other factors that influence crown fire behavior) cannot be changed. Treatment locations were developed in ArcGIS to apply the landscape prescription based on departure from the desired CFR range, field reconnaissance, discussion with resource specialists, and public input. Where at least 50% of the EMDS vegetation polygon was within a proposed treatment unit, changes were made to crown fire risk, flame length, and other vegetation characteristics depending on the type of treatment proposed to emulate their effects on CFR. The resulting dataset was modeled by EMDS and compared to the HRV and FRV to determine whether the proposed treatments and locations would degrade, maintain, or improve the amount and arrangement of each level of crown fire risk in comparison to the HRV and FRV. Using a 50% breakpoint to select polygons affected by proposed changes will slightly underestimate changes in the project area where less than 50% of the polygon was not affected by a proposed treatment.

A small portion of the project area (205 acres) lies outside of the Buttermilk and Libby Creek watersheds, but within the greater Twisp River watershed. This areawas added to the project at the request of adjacent residents in the Buttermilk Firewise Community, and is referred to in this analysis as the Buttermilk Annex. The purpose of proposed treatments in this area is based on the need to reduce fire hazard created by the volume, condition, arrangement, and location of fuels in this area of WUI. The area was added to the project area after photo interpretation and initial EMDS modeling had been completed for the rest of the project area. For these reasons, this portion of the project area was not analyzed with EMDS for consistency with HRV or FRV of any comparable ESR.

Resource Indicator: Fire behavior in WUI

Wildfire risk is defined as the combination of likelihood, intensity, and effects of wildfires. (Scott et al. 2013). In this analysis, two fire characteristics that contribute to wildfire intensity were analyzed: crown fire behavior and flame length. For the purposes of this analysis, Wildland Urban Interface (WUI) consists of the area described by the CWPP, including two priority treatment areas identified by the CWPP that lie within the project area boundary. Fire behavior in the WUI was evaluated by modelingthe existing type of fire behavior (surface or crown) and flame length, fire characteristics that affect wildfire risks to life and property and allow or limit the use of direct suppression opportunities. FlamMap 5.0 software (Finney 2006) was used to spatially model these elements at the stand level under constant weather conditions to determine current values and those expected post-treatment under the modeled conditions.FlamMap modeling used data from LANDFIRE (LANDFIRE 2010, LANDFIRE 2012) to create a 30-meter grid over the project area, with each cell of the grid assigned an elevation, slope, aspect, canopy height, canopy cover, crown base height, crown bulk density, and surface fuel model. The resulting data were clipped to the WUI in the project area using ArcGIS software.

Weather data used in modeling came from the Douglas Ingram Ridge(DIR) Remote Access Weather Station (RAWS), located nine miles southeast of the project area. This RAWS was selected because it is the closest station at a similar elevation and aspect to the project area. Data from the DIR RAWS cover a 20-year period from 1985 to 2016, with hourly readings of temperature, relative humidity, dead and live woody fuel moistures, and herbaceous fuel moistures used in this analysis. Errors and omissions in this data were corrected against the Leecher Mountain and North Cascades Smokejumper Base RAWS. FireFamilyPlus 4.0 software (Bradshaw, McCormick 2000) was used to calculate 90th percentile weather conditions from this data for input to FlamMap. This percentile was selected because it represents the conditions most prevalent during fire growth, excluding 10% of the more severe conditions such as wind events or drought that contribute to extreme fire behavior. Testing proposed treatments against 90th percentile conditions gives a good indication as to whether treatments have the potential to affect fire behavior during the conditions under which most fires grow. Treatments proposed by this project are not intended to effectively change fire behavior past 90th percentile weather as these environmentsinclude low humidities, high temperatures, and winds that create fire behavior that is difficult to alter with fuels treatments.

Winds can accelerate fire characteristics dramatically, but for this analysis, fire behavior was modeled in FlamMap with no wind to show baseline crown fire activity without its influence. Historical wind data from nearby RAWS are available in the analysis file for indications of the wind speeds and directions typical of the area. FlamMap made relative fire behavior calculations for each cell in the grid, assuming that each one burns independently and simultaneously. By creating a static representation of the landscape where there is no predictor of fire movement across the landscape and wind and weather values are constant, FlamMap output is useful for comparing landscapes and treatment effects, and for identifying hazardous fuels and topographic combinations (Stratton 2006). However, this modeling process may underestimate fire behavior due to modeling limitations (for example, it does not consider fire growth through spotting, and keeps interactions between fire, fuel and weather static).

The values used in this analysis will underestimate fire behavior during the latter part of the fire season (approximately late August - September) when fuels are drier, during drought conditions when fuels have cured sooner and more fully than expected, or during windy periods (especially when wind and slope direction align). Modeling parameters and data sources used in this analysis are described in Appendix A.

Crown Fire Behavior in WUI

If wildfires move from the surface into the forest crown, they become more difficult to attack directly with personnel or equipment because fireline intensity increases, rates of spread can outpace available resources, and hazards to personnel increase. In addition to these concerns, crown fires promote more rapid fire growth by producing embers that may spotmiles away (Koo et al. 2010). FlamMap determined fire behavior values for each grid cell as none, surface, passive (single or small groups of trees are involved) or active (where a solid flame develops in the crowns of trees, but the surface and crown phases advance as a linked unit dependent on each other). This analysis groups passive and active crown fire together in recognition of the modeling limitations of FlamMap, which under-represents crown fire,

and because differentiating between the types of crown fire has limited value when the outcome in either case is ultimately the loss of the tree canopy (Scott and Reinhardt 2001; Stratton 2004) with greater potential for higher fireline intensity, resistance to control (defined as the relative difficulty of constructing and holding a control line as affected by resistance to line construction and by fire behavior; NWCG 2003), and more rapid, widespread fire growth through spotting.

The aspect of crown fire behavior most affected by proposed treatments in this project is the surface fuel loading and crown base height (CBH), the lowest height above the ground above which there is sufficient canopy fuel to propagate fire vertically (Scott and Reinhardt 2001). In general, surface fuels combine with slope to create flame lengths that may ignite lower branches; lower CBH values indicate greater susceptibility to ignition that initiates crown fire. Lowering surface fuel loading through underburning, and raising the CBH through scorching lower branches (as may occur during underburning) or thinning the understory (as occurs during ladder fuel reduction thinning and pruning) reduces the risk of crown fire initiation because surface fires have less ground fuel and less canopy fuel to ignite directly (Agee and Skinner, 2005). For this analysis, changes to CBH and resulting crown fire behavior were modeled by changing the surface fuel values and reducing the minimum CBH value within proposed treatment units to 4 meters (12 feet) to simulate the reduction of surface fuels and small-diameter trees through proposed understory thinning and pruning, and scorching of lower branches through proposed prescribed fire treatments.

Flame Length in WUI

In addition to influencing crown fire initiation, flame lengths affect the ability to use direct suppression tactics on wildfires in WUI, which in turn affects the size of the fire. Lower flame lengths may be approached more directly by personnel and ground equipment to contain and suppress wildfires, while longer flame lengths become inapproachable by these resources and must be contained and suppressed indirectly. FlamMap used fuel models and associated fuel loading combined with CBH values and weather parameters to predict flame lengths, which are compared below to established categories (Andrews and Rothermel 1982)that indicate likely suppression responsesdictated by flame length. Because FlamMap works with gridded 30m data that doesn't allow precise translation to the general categories below, an adjusted range is used in this analysis that is allows for an approximation of the same conditions (to a wildland firefighter, a 3.3 flame length is barely distinguishable in intensity from a 4' flame length, and so on for the remaining categories)

- 0 to 4 feet: Personnel can generally attack fire directly at the head or flanks of the fireusing hand tools. Hand fireline should hold the fire effectively. (For this analysis, this categorywill be called Low and include values from 0 to 3.3 feet.)

- 5 to 8 feet: Fires are too intense for direct attack on the head by personnel using hand tools. Hand fireline will not reliably hold the fire. Equipment such as plows, dozers, engines, and retardant aircraft can be effective. (For this analysis, this category will be called Moderate and include values from 3.4 to 9.8 feet.)

- 9 to 12 feet: Control efforts at the head of the fire will probably be ineffective. Personnel and equipment are unable to attack the fire directly. Retardant may be effective. (For this analysis, this category will be called High and include values from 9.9 to 13.1 feet.)

- Greater than 12 feet: Control methods at the head or directly adjacent to the fire are ineffective. Personnel, equipment, and retardant are ineffective. Indirect attack methods must be used, in which the control line is located some considerable distance away from the fire's active edge. (For this analysis, this category will be called Extreme and include values from 13.2 feet or greater.)

Resource Indicator: Fire hazards along FS Roads 43 and 4340

Forest Service Road 4300000 (referred to as FSRoad 43 in this analysis) is the primary ingress/egress route for the project area, with 15.7 miles traversing both sub-watersheds to connect with adjacent county roads. Approximately 3.9 miles of Forest Service Road 4340000 (referred to as FS Road 4340 in this analysis) provides another primary route linking Libby Creek to the adjacent Gold Creek drainage. These two roads offer important ingress/egress option for nearby residents, forest visitors, and suppression resources.During a wildfire, the safest conditions along these roads would be created by conditions that support low flame lengths and as little crown fire as possible. These conditions also increase the likelihood of successfully using these roads as control points during a wildfire.Given that these roads go through many forested areas, a 150' buffer was created around these road features in ArcGIS to detect the type of conditions created by torching trees within 1 to 2 tree lengths of the road. The results of the FlamMap modeling described above wereclipped to this buffer for comparison.

Resource Indicator: Roads in Project Area

The ability to treat vegetation, apply prescribed fire, and respond towildfires onNFS lands in the project area isaffected by road access. Roads that would remain open or allow Administrative Access post-project would provide rapid access to areas for these purposes. Post-project road closures would limit access by vehicles for vegetation and prescribed fire treatments, but would still be available for future access to conduct vegetation and fuels management activities. Closed roads would increase the response time for engines because the road barrier would need to be removed by machinery before emergency access would be possible. Road decommissioning would eliminate vehicle access for ongoing vegetation and prescribed fire treatments and suppression response, and limit the type of resources that may be used to respond to wildfires.

This indicator will compare the miles of roads greater than 0.5 miles that remain post-project to those that would be decommissioned. ArcMapwas used to determine the miles of roads in each category for eachalternative.Changes to roads that are less than 0.5 miles long are not included in this analysis because they access relatively small portions of the landscape that have access from other roads, or access areas with limited need for vegetation management, or offer little effective access for fire management.

Impact Level Definitions

The following definitions will be used to describe the types of impacts that would be caused by proposed actions analyzed in this report.

Type of Impact:

- Adverse: increases the likelihood of uncharacteristic fire behavior and/or risk to developments; reduces access for vegetation/fuels & fire suppression activities.
- Beneficial: decreases the likelihood of uncharacteristic fire behavior and/or risk to developments; maintains or increases access for vegetation/fuels & fire suppression activities.

Duration of Impact:

- Short-term: Impact lasts up to 15 years.
- Long-term: Impact lasts more than 15 years, or (in the case of road decommissioning) is permanent.

Intensity of Impact

- None: No impacts
- Negligible: undetectable change to plant community structure, composition, and/or fuels that shifts fire behavior and ecological functions; minimal impacts to WUI; or access for fuels & fire management changed by less than 10 percent.
- Minor: Slightly noticeable, localized change to plant community structure, composition, and/or fuels that shifts fire behavior and ecological functions on up toone-third of the project area. Noticeable impacts to up to 33% of WUI. Access for vegetation and fire management changes by 11-25%.
- Moderate: Apparent change in plant community structure, composition, and/or fuels that shifts fire behavior and ecological functions on one-third to half of the project area; impacts to33-66% of WUI; or access for vegetation and fire management changed by 26-40%.
- Major: Substantial change in plant community structure, composition, and/or fuels that shifts fire behavior and ecological function acrossmore than 50% of the project area; impacts to over 66% of WUI; or access for vegetation and fire management changed by more than 40%.

Affected Environment

Figure 2 lists the existing condition of the resource indicators used in this analysis. These values reflect those used in Alternative 1 (No Action) because in this alternative, the existing condition would remain unchanged.

Figure 2:Resource Indicators and Measures for the Existing Condition

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
Restoration or maintenance of fire behavior to within the desired range of variability.	The amount and arrangement of each type of crown fire risk in the Buttermilk Creek and Libby Creek watershed as compared to the desired range of variability.	Percentage of landscapein Low, Moderate, & High risk of crown fire	LOW CFR Buttermilk = 32% Below desired range of 45-67% Libby = 53% Within desired range of 41-67%
			MODERATE CFR: Buttermilk = 27% Within desired range of 20-30% Libby = 32% Within desired range of 20-36%
			HIGH CFR: Buttermilk = 41% Above desired range of 12-28% Libby = 16% Within desired range of 5-24%
		Average patch size in Low, Moderate, and High risk of crown fire	LOW CFR Buttermilk = 207 ac Below desired range of 1651-3714 ac Libby = 400 ac Below desired range of 713-3714 ac
			MODERATE CFR: Buttermilk = 305 ac Below desired range of 460-2073 ac Libby = 268 ac Below desired range of 460-1776 ac
			HIGH CFR: Buttermilk = 1504 ac Within desired range of 523-2125 ac Libby = 248 ac Within desired range of 242-934 ac
Wildfire hazard in Wildland Urban Interface	Fire behavior in WUI (23,000 acres total)	Percent of flame length by size class	Low: 52% Moderate:35% High: 4% Extreme: 9%
		Percent of fire behavior by type	None: 3% Surface: 82% Crown: 15%

Resource Element	Resource Indicator	Measure	Existing Condition (Alternative 1)
	Fire behavior along FS Roads 43 and 4340 (701 acres total)	Percent of flame length by size class Percent of fire behavior by type	Low: 85% Moderate: 9% High: 2% Extreme: 4% None: 28% Surface: 61% Crown: 11%
Access for vegetation and fire management	FS Roads in project area.> 0.5 miles (99.3 miles total)	Percent of FS roads greater than ½ mile in length that would remain or be decommissioned.	Remain: 100% Decommissioned: 0%

Overview of crown fire risk

Historically, the areas within the project sub-watersheds that experienced low CFR occupied the hot-dry and warm-dry forest areas in the northern portion of the Buttermilk Creek drainage and the northern and eastern portions of Libby Creek drainage. Fire frequency and severity in these environments weretypical of Fire Regime I, where fire-return intervals ranged from 0 to 35 years with mostly low-severity fires that replaced< 25% of dominant overstory vegetation(Hardy et al. 1998; Hann and Strohn 2001; Hann et al. 2003). Forest stand structure in these areas would have been more open because wildfires that consumed surface fuels also killed smaller seedlings and saplings and scorched lower tree branches, keeping the likelihood of surface-to-crown fire transition low. Crown fire would have been the exception, with larger trees being highly resilient to wildfire because low-severity wildfire would have been less likely to reach higher tree canopies or penetrate the thick bark common to the dominant tree species of this area. As described in the Vegetation specialist report, past timber harvest in the sub-watersheds have altered the response to wildfires by reducing the proportion of fire-tolerant forest cover types that have been replaced with more shade-tolerant species. This change also caused an increase in tree canopy cover and lowered canopy-base-heights in many dry forested areas, allowing surface fires to more readily carry into overstory crowns. Harvest removed many of the large fire-resistant trees, leaving younger trees that are less tolerant to fire because of thinner bark and lower canopy base heights. Other management activities such as fire suppression (that allowed accumulation of surface fuels and development of understory tree layer) and pre-1970s grazing practices (that created bare soil over large areas and fostered germination of seedlings) helped many of dry forested areas in the Buttermilk drainage to develop a greater CFR than historically. Surface fires have a greater likelihood of transitioning into crown fire, causing uncharacteristic adverse fire effects such as more widespread tree mortality and attendant adverse effects on wildlife and aquatic habitat. Because many of the areas that typically had low CFR now have moderate or high CFR, more of this landscape is at risk for

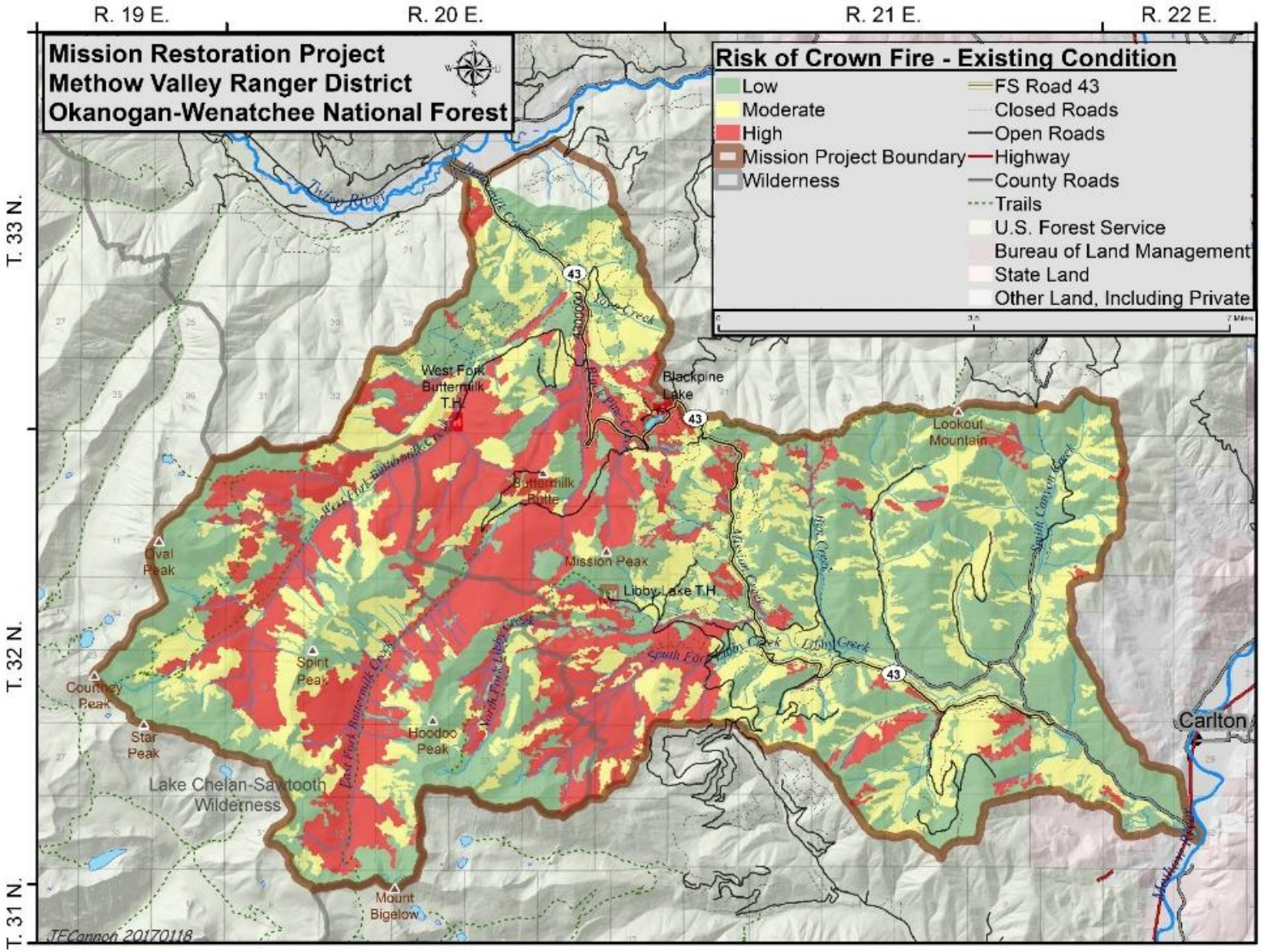
uncharacteristically severe wildfires with detrimental effects to hydrologic and soil processes, as well as terrestrial and aquatic habitat.

Areas of moderate CFR historically occupied the cool-dry portions of the sub-watershedsand generally experienced mixed-severity fire behavior typical of Fire Regime III, where fire-return intervals ranged from 35 to 200 years (ibid). Mixed-severity fire behavior would have included a mosaic of low to high fire severity. These areas generally lie in mid-elevation in the project area (approximately 3000-4000') and/or on north aspects. Areas of high CFR historically occupied the cool-moist portions of the sub-watersheds that generally lie at higher elevations (approximately 4000' or more) or along narrow perennial stream channels; these areas historically experienced high-severity, or stand-replacement, fires typical of Fire Regime IV, where fire return intervals ranged from 35 to 200 year-intervals (ibid).

ResourceIndicator: The amount and arrangement of each type of crown fire risk in the Buttermilk Creek watershed as compared to the desired range of variability.

Current CFR in the Buttermilk Creek and Libby Creek drainages is shown in Figure 3 below. The Buttermilk Creek drainage has less area with low CFR than desired, which means that more of the forested area in this sub-watershed lies in moderate or high CFR with greater likelihood of uncharacteristic fire behavior and effects. The amount of Buttermilk Creek with moderate CFR is within the desired range, allowing room to treat these areas to maintain vegetation characteristics that improve resiliency to wildfire.High CFR occupies more of this drainage than is desired, dominating locations where low-severity wildfire was commonhistorically.

Figure 3:Existing crown fire risk in the project area.



The average patch size of areas with low CFR in the Buttermilk drainage is well below the desired range, and areas of moderate CFR are slightly below the desired range. These types of CFR are fragmented into smaller pieces than desired, and, during a wildfire, would be more likely to be overcome by the type of fire disturbance occurring in adjacentpatches. For example, smaller patches that historically experienced low CFR lie adjacent to patches with moderate or high CFR that are more likely to support and transfer uncharacteristic fire behavior and effects into and through the patches of low CFR. Since areas with moderate CFR historically experienced mixed-severity fire behavior that included low and high fire severity, being influenced by fire behavior in adjacent patches with low or high CFR would cause effects within the range of historical fire behavior of this crown fire type. The patch size of high CFR is within the desired range. The dominance of high CFR around smaller patches of low and moderate CFR makes these areas vulnerable to uncharacteristic wildfire behavior with high likelihood of more severefire behavior and effects than desired.

Another consideration for patch size is how it influences post-disturbance recovery rates. Ecological properties of a patch are influenced by the surrounding neighborhood, and the magnitude of these influences are affected by patch size and shape (McGarigal et al. 2015). The recovery process for species removed by a disturbance (like wildfire) is closely connected to the dispersal capability pf that species and the distance between the disturbed site and surviving source populations (Paine 2016). The ponderosa pine and Douglas-fir tree species at risk for mortality in areas with low CFR have seeds that are too large to be transported great distances, and their post-fire recolonization rate and success is heavily influenced by proximity to seed sources. If uncharacteristic fire behavior causes increased mortality in larger patches that cross low, moderate, and high CFR, trees would be slower to recolonize because of distance from seed sources. When subsequent disturbances continue to occur during its recovery period, they create conditions that can lead to the formation of alternative vegetation communities (ibid). A local example of this lies adjacent to the project area in the boundary of the 2001 Libby South Fire that burned again in the 2014 Carlton Complex fire. The 2001 fire created a large patch of high-severity fire in a hot-dry, warm-dry forested area that would have experienced frequent, low-severity fires historically. Conifer seedlings had started to naturally colonize the edges of this burned area and were replanted in other small portions, but outside of these locations, herbaceous cover (grass and shrubs) dominated the area. When the area burned again in 2014, many of these seedlings were killed and the patch size of high-mortality fire was enlarged further into adjacent stands of mature Douglas-fir and ponderosa pine, creating more distance from seed sources.

The length and severity of wildfire seasons across the Western U.S. is expected to increase (Liu et al. 2010; Climate Central 2012; Westerling et al. 2006). The project landscape is predisposed to burning in the dry summer climate (Agee and Skinner 2005) and, coupled with the normal pattern and frequency of lightning ignitions, makes wildfires a certainty, not a possibility. Fire frequency and behavior would be exacerbated by anticipated likely climate changes such as reduced snowpack with earlier melt-off, drought, longer summer weather conditions, and lower stream flow levels. This would create conditions that allow fuels to dry out earlier and more completely, adding to available fuels for wildfires (Millar et al. 2007). The combination of these factors create the strong possibility for more frequent fires with

potential for ignition over a longer period of the growing season and greater likelihood for a recently disturbed area to experience another disturbance before recovery is complete.

ResourceIndicator: The amount and arrangement of each type of crown fire risk in the LibbyCreek watershed as compared to the desired range of variability.

The proportions of the landscape occupied by low, moderate, and highCFR in Libby Creekarewithin the middle or high end of their desired ranges. The areas with low and moderate CFR would benefit from further treatments to help maintain or improve resilience to wildfire without moving these characteristics outside of the desired ranges. However, the arrangement of low and moderate CFRis undesirable because each type is fragmented into too many small patches that lie close together, making them more vulnerable to more severe type of disturbance occurring in adjacent larger patches and possibly affecting their post-fire recovery as described for the Buttermilk Creek drainage above.In several location, smaller patches of low CFR lie adjacent to moderate or high CFR, indicating a high potential for uncharacteristic fire behavior and effects from the more dominant patches. Similar to Buttermilk Creek, the areas with the most departure from the desired range lie in the dry forested portions of the drainage that would have experience similar fire behavior as described for Fire Regime I.

Resource Indicator: Fire behavior in WUI

The project area contains approximately 23,000 acres of WUI as defined in the CWPP (see Figure 4). About 16,400 acres of this amount is identified in the CWPP as Rural WUI; most of this lies in the Libby Creek drainage with a small portion in the Buttermilk Creek drainage around Blackpine Lake Campground. About 5000 acres of WUI within the project area is part of the CWPP's "Twisp-Carlton Neighborhoods" and is characterized in the CWPP as having moderate to high risk of wildfires, especially on mid- to upper-slopes and in developed drainages. Within this area, the CWPP further identifies Libby Creek as a potential "hot spot" for fire activity due to economic values, fuel types, fire history, and access issues. The project area also contains approximately 1600 acres of WUI in the Buttermilk Creek vicinity is in another priority treatment area, the "Twisp River Neighborhood", and is characterized in the CWPP as having very high risk of experiencing a damaging wildfire in part because of existing fuel types, fuel loading, and topography. Recommended treatments in both areas include fuel reduction around private lands and along ingress/egress routes.

FlamMap modeling under 90th percentile conditions with no wind indicates that approximately 15% of the WUI within the project area is at risk for crown fires, and 58% of the WUI is likely to experience moderate to extreme flame lengths. Large patches of crown fire risk exist in the Libby Creek drainage adjacent to private lands with developments. Crown fire risk and flame lengths would likely increase during an actual wildfire because fires often occur during windy periods that accelerate fire behavior;when winds align with slope direction, these values would increase at an even greater rate. Risks to developed areas increase with longer flame lengths and increase crown fire because these types of fire behaviorgenerate more fire intensity that limit direct attack options and produce firebrands that are lofted in the fire's convective column, providing potential ignitions sources as they land. Greater flame lengths alsoincrease risk for firefighters, limit direct attack opportunities, and increase the risk of wildfires moving off NFS lands to private lands (or vice versa). When direct attack options are limited, fire

growth may continue unabated until suppression resources find and prepare a suitable barrier, or wait until the fire behavior diminishes enough to attack directly. Private lands in the project area generally lie at the bottom of drainages and, while some landowners have reduced fuels and used Firewise principles in building materials and landscaping, the risk of a wildfire on private lands moving on to NFS lands still exist. Figure 4 shows current fire behavior in the WUI under modeled conditions.

ResourceIndicator:Fire behavior along FS Roads 43 and 4340

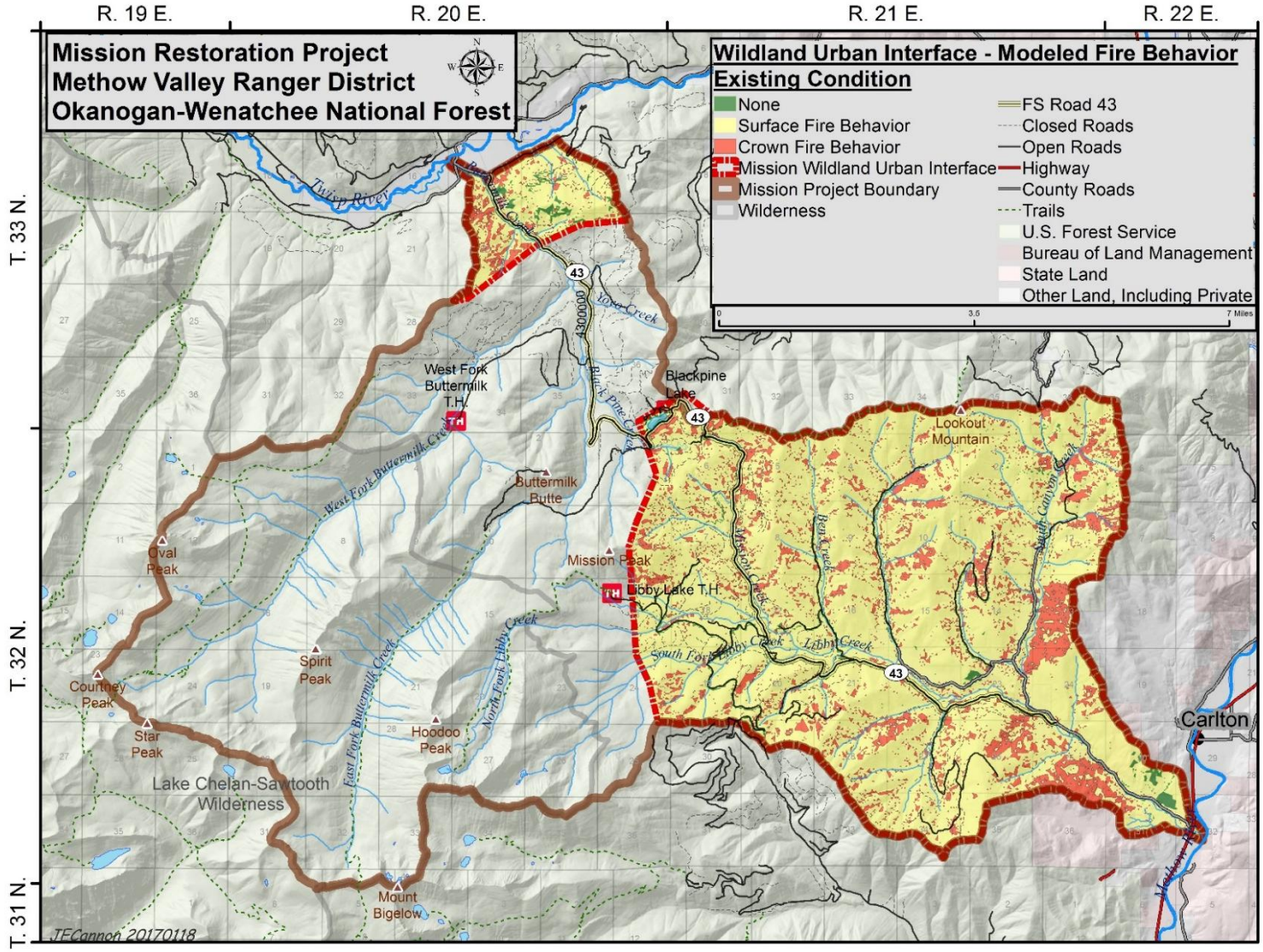
Approximately 21 miles of FS Roads 43 and 4340 lie within the project area. During the 2014 Carlton Complex wildfire, some understory thinning and pruning occurred within 25 to 50 feet of approximately 7 miles on the south side of FSR 43. This work, performed with restricted time and resources during fire suppression efforts, created a narrow buffer along one side of this road that where wildfire behavior would likely be reduced, but the potential for crown fire initiation exists just beyond this narrow buffer because fuel continuity from the surface to understory trees with low branches to the overstory tree canopy above the road still exists. Crown fire initiation within 50' of these roads would have a strong potential to carry fire over the road or increase fire intensity, either of which would limit use of these roads during a wildfire.

Buffering these roads by 150 feet on either side to model fire behavior adjacent to the roads created an area of 701 acres. FlamMap modeling under 90th percentile conditions with no wind indicates that approximately 11% is at risk for crown fires, and 15% is likely to experience moderate to extreme flame lengths.These values would likely increase during an actual wildfire because fires often occur during windy periods that accelerate fire behavior; when winds align with slope direction, these values would increase at an even greater rate.The smaller areas of greater fire behavior are interspersed between areas of surface fire with low flame lengths, but even a small area of crown fire or moderate to extreme flame length could serve to block ingress or egress to the area,create greater risks to those using the roads, limit direct attack options, and produce firebrands that are lofted in the fire's convective column, providing potential ignitions sources as they land.Asuse of these roads becomes limited by fire behavior, nearby residents, forest visitors, and suppression resources may be unable to leave or access the area as needed.

ResourceIndicator:FS Roads greater than 0.5 miles

The project area contains approximately 134.6 miles of roads on National Forest System (NFS) lands. Of these roads, 99.3 miles are at least 0.5 miles long and access substantial areas for vegetation or fire management. Whether open or closed, these roads maintain access to several key locations in the project area and are important for continuing vegetation management, prescribed fire treatments, and fire suppression, especially where these roads provide substantial access to WUI, ridgelines, and midslope hillsides. About 54% of these roads are currently open, providing continual access, while the remaining 46% are closed and can be re-opened rapidly during emergency fire response, or remain closed until future management needs require access. Roads on the project landscape provide for more rapid fire suppression access with a wider range of options, including the potential use of equipment such as engines and tenders. Both open and closed roads provide options for containment lines and escape routes.

Figure 4:Existing condition of modeled fire behavior in the Wildland Urban Interface.



In one area across the bridge over the West Fork Buttermilk Creek, approximately 10.7miles of roads greater than 0.5 miles are currently designated as closed because the bridge accessing these roads was closed due to safety concerns around 2011. The bridgehas not yet been replaced, leaving these roads closed because of circumstance and not because of resource concerns supported by an environmental analysis and subsequent decision.The condition of the bridge limits efficient and effective land management access on approximately 920 acres of NFS lands; as long as these roads remain closed, future treatment options will be limited. Suppression options in this area are currently restricted because equipment such as engines, tenders, or dozers cannot access this area. Wildfire response here will likely rely heavily on limited aerially delivered resources such as smokejumpers or rapellers, and when these resources are not available, ground resources will require a longer response time to access much of the area. The limitation on vehicles makes the road less useful as a rapid escape route, further narrowing suppression response options in this area during wildfires.

Environmental Consequences

Alternative 1 – No Action

ResourceIndicator: The amount and arrangement of each type of crown fire risk in the Buttermilk Creek watershed as compared to the desired level between historical and future ranges of variability.

If no action is taken to increase the amount and average patch size of low CFR levels and decrease the amount of high CFR in dry forests, then these areas would likely experience adverse, long-term, minor to major effects from uncharacteristic, high-severity wildfire behavior. The direction and amount of departure will likely increase because projected wildfire behavior and climate impacts would likely cause uncharacteristically severe impacts that further shift the type and amount of departures away from the desired range. The resilience of dry forested areas in the landscape would decline further because areas dominated by high CFR would influence wildfire behavior in adjacent uncharacteristically smaller patches of low CFR, causing unusually severe fire effects to be more widespread than historically. Terrestrial and aquatic habitat would have a strong likelihood for negative impacts including loss of vegetation and browse. Surface fuels and live vegetation would continue to increase over time until affected by wildfires, or other disturbances.

Areas of moderate CFR would experience short-term to adverse, long-term,minor to moderate effects as dependingbecause their spatial distribution in the project area makes them vulnerable to more severe behavior from adjacent areas with high CFR. Rather than experiencing a range of fire severity, these areas are at risk of experiencing more crown fire behaviorwith greater rates of vegetation mortality during wildfires with adverse impacts to aquatic and terrestrial habitat. Vegetation recovery would likely take longer because of the potential for more severe fire effects over a larger area that decreases proximity to seed sources. Smallerpatches of low to moderate CFR would be less likely to sustain characteristic types of fire behavior and would be more likely to be influenced by adjacent, more severe types of wildfire. Many streams and forested stands in the drainage provide direct habitat for Threatened or Endangered species or connect to this habitat, and lie within or adjacent to areas where the amount and arrangement of low CFR is outside of the desired range. Past studies suggest substantial

continuity in fire disturbances between sideslope and adjacent riparian forests (Everett et al. 2001). While some wildfires in the pre-suppression era may have stopped when reaching more moist riparian areas, the likelihood of stream channels providing an effective change in burning conditions that may stop or diminish fire behavior decreases on a landscape with an uncharacteristic tendency toward higher CFR. Many streams are surrounded by continual vegetation from just above the forest floor through multiple canopy layers on both sides of the stream, increasing available fuel for wildfires occurring on adjacent patches with high CFR to carry fire through riparian areas. Increased mortality that is likely to accompany crown fires would have greater potential to reduce shade along streams, increasing water temperature. Uncharacteristically high-severity fires would likely result in the loss of more vegetation across a larger portion of this drainage, increasing the chance that post-fire runoff would carry greater loads of sediment to streams and compromising aquatic habitat.

Given proximity to WUI and other resource values, it is highly likely that fire suppression will continue in the project area, especially given the level and direction of departure in CFR levels and the potential for undesirable fire behavior and effects. When ignitions occur, current LRMP and NWFP standards and guidelines and fire management policies require consideration of the values at risk, including human lives and developments and terrestrial and aquatic habitats. In some areas within the project boundary, management direction requires that fires be kept as small as possible when feasible. Therefore, the option of using wildfires to help move CFR levels into the desired amount and arrangement on the landscape is not currently viable Wildfires would be more likely to result in an adverse, long-term, moderate impact to dry forests in the sub-watershed. As a result, taking no action would not meet Purpose and Needs #1, #3, or #4.

ResourceIndicator: The amount and arrangement of each type of crown fire risk in the Libby Creek watershed as compared to the desired level between historical and future ranges of variability.

Without intervention, the amount of this landscape at each level of low, moderate, or high CFR would likely remain within the desired range until affected by wildfire, insect and disease outbreak, and/or climate impacts such as drought. However, since areas with low and moderate CFR are below the desired range, they would be more at risk to experience the type of disturbance occurring in the patch with the more dominant type of CFR. Areas with small patches of low CFR that lie adjacent to areas of high CFR would be more likely to experience uncharacteristic high-severity fire. Wildfires would be more likely to result in an adverse, long-term, moderateto major impacts to dry forested areas within the sub-watershed. As a result, taking no action would not meet Purpose and Needs #1, #3 or #4.

ResourceIndicator: Fire behavior in WUI

The result of taking no action in WUI to reduce fire hazard would be adverse, long-term, moderate impact on fire behavior because the risk of crown fire initiation would continue to grow due to ongoing fire suppression in around the WUI. In addition, natural processes would continue to allow accumulation of dead fuels and live vegetation faster than natural decomposition in this predominantly dry ecosystem could remove it. The risks to developed areas that accompany increased flame lengths and crown fire behavior would continue to exist, with fire intensity that limits direct attack options, torching that produces firebrands that contribute to spotting, and overall fire behavior that increases risks to

firefighters and developments and the likelihood of wildfires moving off NFS lands to private lands (or vice versa). As a result, taking no action would not meet Purpose and Need #6.

ResourceIndicator:Fire behavior along FS Roads 43 and 4340

The result of taking no action to reduce fire hazards along FSR 43 and 4340 would be adverse, long-term, minor to moderate impacts because hazards would continue to increase along more of these roads as surface fuels accumulated, continued growth of vegetation created more ladder fuels to initiate crown fire, and surface fires included high flame lengths that increase fire intensity. These effects would restrict the use of these roads for ingress/egress, limit their usefulness as fuelbreaks during a wildfire, and curtail the use of direct suppression strategies with personnel and equipment. As a result, taking no action would not meet Purpose and Need #6.

ResourceIndicator:FS Roads greater than 0.5 miles

Keeping roads in their current state would create beneficial, long-term, moderate impacts to access for vegetation and fire management. If roads are kept in their current state, open road access to several ridges and mid-slope forested stands would provide more options to continue using a wider variety of tools for forest management and allowing for more rapid access with equipment and personnel during fire suppression efforts. Roads that are currently closed would be remain on the landscape for use during future land management activities, and could be re-opened quickly to provide emergency fire suppression access. Open and closed roads would be available for use as escape routes. Although this results in more favorable access for vegetation and fire management resources than taking actions to close or decommissioning roads, taking no action would not meet Purpose and Need #7 because keeping all roads as they are in the project area does not provide for a road system that can be maintained to current standards.

Alternatives 2 and 3: Direct and Indirect Effects Common to Both Action Alternatives or to Alternative 2 Only

Proposed thinning and prescribed fire treatments that affect the amount and arrangement of CFR in Buttermilk Creek or Libby Creek, fire hazards in WUI, or fire hazards along FSR 43 or FSR 4340are identical in Alternatives 2 and 3. Thinning and prescribed fire methods and prescriptions are described in Appendix A of the Mission Restoration Project Preliminary Environmental Assessment, including maintenance burning that would help maintain low levels of surface fuels and reduce small-diameter understory vegetation. The effects of these proposed treatments for both alternatives will be described in this section. With regards to proposed transportation changes, this section will only describe the effects of the Alternative 2 proposed transportation changes on access for vegetation and fire management.

Proposed Actions Dismissed from Further Consideration

The following proposed actions will not be considered further in this analysis because they would have no measurable effect on restoration or maintenance of CFR to within the desired range of variability, changing wildfire risk in the WUI, or altering access for vegetation and fire management: soil restoration;

rock armoring; replacing undersized culverts or installing fish culverts; beaver habitat or coarse woody debris enhancement; or creating hardened fords.

The following discussion addresses where the effects of proposed actions are identical to both action alternatives.

Project Design Features

Figure 5 lists the design features used for prescribed burning. The effects described below are based on using these design features.

Figure 5:Design Features.

Number	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
1	Underburns may extend beyond planned burn boundaries to utilize a nearby road, cow trail, ridge line, or skid trail if doing so creates safer holding conditions and/or minimizes ground disturbance from fireline construction. Coordination with resource specialists will occur during burn planning to assure that required surveys are completed as necessary and relevant design criteria and burn objectives in this document are followed.	Minimizes hazards to burn crews, increase holding options, and minimize ground-disturbing fireline construction.	Moderate - High	Increased safety risk for burn personnel; increased risk of escape; increased impacts from fireline construction.

Number	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
2	Fireline will utilize erosion control measures during construction and rehabilitation. Waterbars will be constructed when the fireline is created using Best Management Practices (BMPs) soils erosion slope designations. No hand fireline construction will occur within existing New Invader invasive plant patches. Populations near proposed containment lines will be identified on Burn Plan maps. In Riparian Reserves (RR), minimize hand fireline and use a MIST approach in whenever feasible (generally less than 2'width to mineral soil). Fireline may be constructed within 100 feet of a stream if the line is located outside/above the defined inner gorge. Fireline in RRs will not run perpendicular to the stream channel in the inner gorge of the RR. No machine fireline will be constructed in RRs. During machine fireline construction, surface vegetation will be scraped away, while minimizing damage to live root crowns of native grasses and shrubs. This will allow for rapid post-burning recovery of the fireline, with residual intact roots helping prevent soil displacement and reducing the potential for invasive plant introduction, establishment, and spread. Post-burn fireline rehabilitation needs will be reviewed by soils, botany, and/or invasive species staff and fuels staff. If seeding is necessary, firelines will be seeded using native species vegetation. Some small trees (generally < 10" DBH) and some down logs may be cut and/or moved along the fireline to prevent undesirable fire spread but no material will be removed from the site. Where accessible from existing roads or trails, firelines will be rehabilitated using methods that prevent public use of firelines as hiking, biking, motorcycle, and/or ATV/UTV routes, as well as preventing use by stock to access riparian	Restore firelines to reduce erosion, inhibit invasive plant spread, minimize movement of wood, and inhibit use by the public for motorized and non-motorized recreation. Limit impact of fireline in RRs. Prevent excessive compaction and ground disturbance from machinery in RRs.	Moderate - High	Increased soil erosion, invasive plant spread, and visual impacts. Increased soil disturbance and surface erosion in Riparian Reserves.

Number	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
3	Resource Specialists will be given a timely opportunity to review burn plans and contracts before implementation.	Ensures that design criteria and mitigation measures are included in contracts and burn plans; provide for consideration of new resource concerns that have surfaced since NEPA decision.	High	Contracts or burn plans may not meet NEPA intent and/or resource concerns that have surfaced since NEPA decision may not be considered, thus causing undesired resource impacts.

Completion of underburn projects proposed in this project would require about 29.4 miles of hand fireline at 12 to 24-inch width, created with hand tools such as hoes and pulaskis, and 2.6miles of machine fireline at 3 to 5-foot width, created by an excavator or dozer. Some small trees (generally less than 10" dbh) may be cut and other trees pruned adjacent to the fireline to prevent unwanted spread of fire. These materials would be left onsite. Hand or machine fireline would scrape debris off the ground to expose mineral soil, and will include erosion control design such as waterbars during construction to minimize movement of soil. Fireline would be constructed generally within a year of the planned ignition date, and would remain until completion of ignition and the burn unit is declared "out" after ignition. Burn unit boundaries would use existing roads, animal paths, rock outcroppings, or other defensible barriers wherever practicable and safe to reduce the need for fireline construction. Fireline would avoid existing populations of invasive plants, and would be rehabilitated post-project as needed following post-burn review by staff. Fireline adjacent to existing roads would be rehabilitated using brush, reccontouring, or other methods to prevent their use as hiking, biking, or off-road motorized vehicle routes or as routes that cattle could use to access riparian areas. No machine fireline would be constructed in Riparian Reserves; hand fireline in this designation would use minimum impact suppression tactics (MIST) wherever feasible. Further fireline design criteria is described in Appendix D of the Mission Restoration Project Preliminary Environmental Assessment.

Effects

Figures 6 lists the resource indicator values common to Alternatives 2 and 3; Figure 7 lists those applicable to Alternative 2 only.

Figure 6:Resource Indicators and Measures Common to Alternatives 2 and 3

Resource Element	Resource Indicator	Measure	Alternatives 2 and 3
Restoration or maintenance of fire behavior to within the desired range of variability.	The amount and arrangement of each type of crown fire risk in the Buttermilk Creek and Libby Creek watershed as compared to the desired range of variability.	Percentage of landscapein Low, Moderate, & High risk of crown fire	**LOW CFR** Buttermilk = 39% Increased 7% towards desired range of 45-67% Libby = 65% Increased 12%, remains within desired range of 41-67%
			MODERATE CFR: Buttermilk = 23% Decreased 4%, still within desired range of 20-30% Libby = 21% Decreased 11%, remains within desired range of 20-36%
			HIGH CFR: Buttermilk = 38% Decreased 3% towards desired range of 12-28% Libby = 14% Decreased 2%, remains within desired range of 5-24%
		Average patch size in Low, Moderate, and High risk of crown fire	**LOW CFR** Buttermilk = 299 ac Increased 92 ac towards desired range of 1651-3714 ac Libby = 825 ac Increased 425 ac, now within desired range of 713-3714 ac
			MODERATE CFR: Buttermilk = 237 ac Decreased 68 ac away from desired range of 460-2073 ac Libby = 170 ac Decreased 98 ac away from desired range of 460-1776 ac

Resource Element	Resource Indicator	Measure	Alternatives 2 and 3
			HIGH CFR: Buttermilk = 1734 ac Increased 230 ac, remains within desired range of 523-2125 ac Libby = 264 ac Increased 16ac, remains within desired range of 242-934 ac
Wildfire hazard in Wildland Urban Interface	Fire behavior in WUI (22,890 acres total)	Percent of flame length by size class	Low: 57% Moderate: 32% High: 3% Extreme: 8%
		Percent of fire behavior by type	None: 3% Surface: 88% Crown: 9%
	Fire behavioralongFS Roads 43 and 4340 (701 acres total)	Percent of flame length by size class	Low: 92% Moderate: 6% High: 1% Extreme: 1%
		Percent of fire behavior by type	None: 28% Surface: 69% Crown: 3%

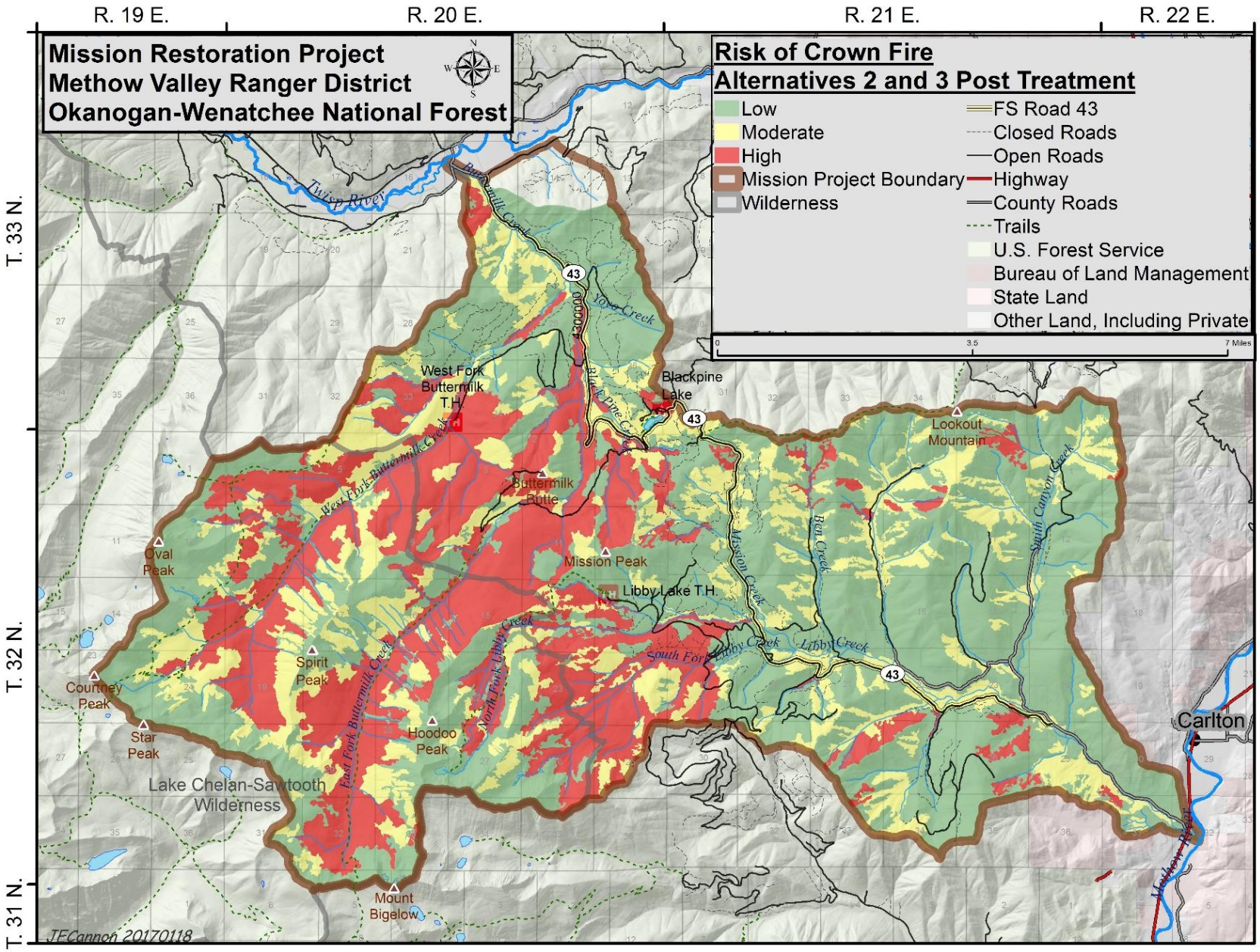
Figure 7:Resource Indicators and Measures Applicable to Alternative 2 Only.

Resource Element	Resource Indicator	Measure	Alternative 2
Access for vegetation and fire management	FS Roads in project area> 0.5 miles (99.3 miles total)	Percent of FS roads greater than ½ mile in length that would remain or be decommissioned.	Remain: 89% Decommissioned:11%

Resource Indicator: The amount and arrangement of each type of crown fire risk in the Buttermilk Creek watershed as compared to the desired range of variability.

Post-treatment changes in CFR in the Buttermilk and Libby Creek drainages is shown in Figure 8 below. While fire behavior is strongly influenced by climate and topography, these factors cannot be easily altered by treatments; therefore the treatments proposed in this project to address any aspect of wildfire behavior focus on altering the amount and arrangement of surface fuels and standing vegetation. The combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, long-term, minor effect in re-establishing the desired amount and arrangement of low CFR because these areas are not widespread across the drainage. The combination of understory thinning and prescribed fire (without overstory thinning) would create beneficial, short-

Figure 8:Post-treatment crown fire risk in project area.



term, moderate effects on re-establishing the desired amount and arrangement of low CFR because they affect more areas within the drainage. Proposed management actions including thinning and prescribed fire treatments would increase the amount of low CFR in the Buttermilk drainage, although the amount would remain below desired range after project implementation was complete. The average patch size of areas with low CFR would increase slightly but remain well below the desired range. Additional management actions would be needed to continue to increase the areaand average patch size with low CFR after this project is completed. The combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, long-term, minor effect in re-establishing the desired amount and arrangement of low CFR because these areas are not widespread across the drainage. The combination of understory thinning and prescribed fire (without overstory thinning) would create beneficial, short-term, moderate effects on re-establishing the desired amount and arrangement of low CFR because they affect more areas within the drainage. Where underburning is proposed, the initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would reduce surface fuel loading, scorch lower tree branches, and help maintain the open arrangement of understory trees to limit the potential for crown fire initiation. This would create a beneficial, long-term, minor to moderate effect by extending the impact of the first treatments. Management actions like thinning and prescribed fire treatments are viable fire surrogates that would help restore desired fire behavior and effects (USDA 2012b; Agee and Skinner 2005; Covington 2003; Prichard et al. 2010; Stephens et al. 2012). The effects of proposed treatments would include:

1. Increasing canopy base heights by thinning units by thinning and pruning small-diameter understory trees up to approximately 8 inches diameter at breast height (DBH) to reduce ladder fuels that provide a path for fire to move from the surface to the overstory tree canopy, or though the overstory. This treatment would mimic understory tree mortality and lower branch removal caused by wildfires (Peterson et al. 2005).

2. Reducing overstory canopy bulk density and canopy continuity in overstory thinning units by removing trees averaging 10 inches DBH and 20 feet tall.

3. Reducing surface fuels in thinning units through a combination of piling and pile burning, and underburning. In units where debris was piled, surface fuel reduction would generally be limited to the footprint of the piles.

In addition to these effects, treatments would create a more open landscape where understory herbaceous vegetation would eventually grow, contributing to fuel loading and possibly increasing fire spread rates. The flame lengths created by these fuels, however, would still be less than those created by torching trees, the fire behavior more likely without thinning. In opening up the overstory and understory, thinning may contribute to an increase in surface wind speeds by reducing stand density that would have helped limit the influence of winds on fire behavior. Thinning would also allow wind and sunlight to dry out surface fuels (Agee and Skinner, 2005). These concerns, however, are countered by the advantages of fire-resilient forests describedin Figure 9 (ibid).

Figure 9:Principles of Fire-Resilient Forests.

Principle	Effect	Advantage
Reduce surface fuel	Reduce potential flame length	Easier control, less torching/spotting
Increase canopy base height	Requires longer flame length to begin torching	Less torching/spotting
Decrease crown density	Decreases probability of tree-to-tree crown fire	Reduces crown fire potential
Retain larger trees	Remaining trees have thicker bark and taller crowns	Increases survivability of trees

In areas with moderate CFR, the combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, long-term, minor effect in maintaining the desired amount of moderate CFR because these treatments increase resilience to wildfires a described above over limited areas of moderate CFR. The combination of understory thinning and prescribed fire (without overstory thinning) would create beneficial, short-term, moderate effects on maintaining the desired amount of moderate CFR because they affect more areas within the drainage. The amount of moderate CFR in the Buttermilk Creek drainage would decrease as some of these areas would be treated to increase the area and average patch size of low CFR, but the overall amount of moderate CFR would remain within the desired range. The initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would reduce surface fuel loading, scorch lower tree branches, and help maintain the open arrangement of understory trees to limit the potential for crown fire initiation. The average patch size of areas with moderate CFR would move further from the desired range because these areas would be treated in some locations to create larger patches of low CFR. The remaining smaller patches of moderate CFR would be likely to have fire behavior related to low CFR (low fire severity, low mortality rates) infiltrate the smaller remaining patches of moderate CFR. Post-fire, the rapid rate of recovery from adjacent areas of low CFR would likely affect that of areas with moderate CFR. This type of fire behavior and recovery would increase resilience to wildfire in smaller patches of moderate CFR and is within the range of low-to-high severity fire behavior common to these areas.

The combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, short-term, minor effect in moving toward the desired amount of high CFR because these treatments affect small areas of high CFR in limited areas of the drainage. The amount of high CFR in this drainage would decrease post-treatment to create areas of low CFR, but remain above the desired range, indicating that more treatments would be needed in the future to reduce the amount of high CFR in this drainage. The average patch size of areas with high CFR would increase, but remain within the desired range. The amount and arrangement of high CFR would remain largely unaffected where it existed historically in the upland areas in the southern portion of this drainage. These areas are within a designated wilderness or inventoried roadless area (IRA) with none to very limited options for active management to reduce CFR; these areas will likely remain unchanged till affected by wildfire. Some areas of high CFR lie outside in the lower portion of the drainage, outside of a wilderness or IRA, but

have limited to no road access to provide for safe conditions for personnel during prescribed fire activities.

Resource Indicator: The amount and arrangement of each type of crown fire risk in the Libby Creek watershed as compared to the desired range of variability.

The combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, long-term, minor to moderate effect in maintaining or re-establishing the desired amount and arrangement of low CFR because the arrangement of treated areas would help create more continuous patches of low CFR. The combination of understory thinning and prescribed fire (without overstory thinning) would create beneficial, short-term, moderate effects on re-establishing the desired amount and arrangement of low CFR because they affect more areas within the drainage. The amount of low CFR in the Libby Creek drainage would increase and remain within the desired range after project implementation was complete. The average patch size of areas with low CFR would increase to within the desired range. The initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would reduce surface fuel loading, scorch lower tree branches, and help maintain the open arrangement of understory trees to limit the potential for crown fire initiation.The effects of proposed treatments would include those listed in Figure 9 above.

In areas with moderate CFR, the combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, long-term, minor effect in maintaining the desired amount of moderate CFR because these treatments increase resilience to wildfires a described above over limited areas of moderate CFR. The combination of understory thinning and prescribed fire (without overstory thinning) would create beneficial, short-term, moderate effects on maintaining the desired amount of moderate CFR because they affect more areas within the drainage. The amount of moderate CFR in the Libby Creek drainage would decrease as some of these areas would be treated to increase the area and average patch size of low CFR, but the overall amount of moderate CFR would remain within the desired range. The initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would reduce surface fuel loading, scorch lower tree branches, and help maintain the open arrangement of understory trees to limit the potential for crown fire initiation. The average patch size of areas with moderate CFR would move further from the desired range because these areas would be treated in some locations to create larger patches of low CFR. The remaining smaller patches of moderate CFR would be likely to have fire behavior related to low CFR (low fire severity, low mortality rates) infiltrate the smaller remaining patches of moderate CFR. Post-fire, the rapid rate of recovery from adjacent areas of low CFR would likely affect that of areas with moderate CFR. This type of fire behavior and recovery would increase resilience to wildfire in smaller patches of moderate CFR and is within the range of low-to-high severity fire behavior common to these areas.

The combination of overstory thinning, understory thinning, and prescribed fire treatments would create a beneficial, short-term, minor effect in maintaining the desired amount of high CFR because these treatments keep this risk level from increasing in undesirable areas such as adjacent to WUI in the drainage. The amount of high CFR in this drainage would decrease post-treatment to create areas of low CFR and remains within the desired range. The average patch size of areas with high CFR would increase,

but remain within the desired range. The amount and arrangement of high CFR would remain largely unaffected where it existed historically in the upland areas in west-southwestern portions of this drainage. These areas are within a designated wilderness or inventoried roadless area (IRA) with none to very limited options for active management to alterhigh CFR; these areas will likely remain unchanged till affected by wildfire.

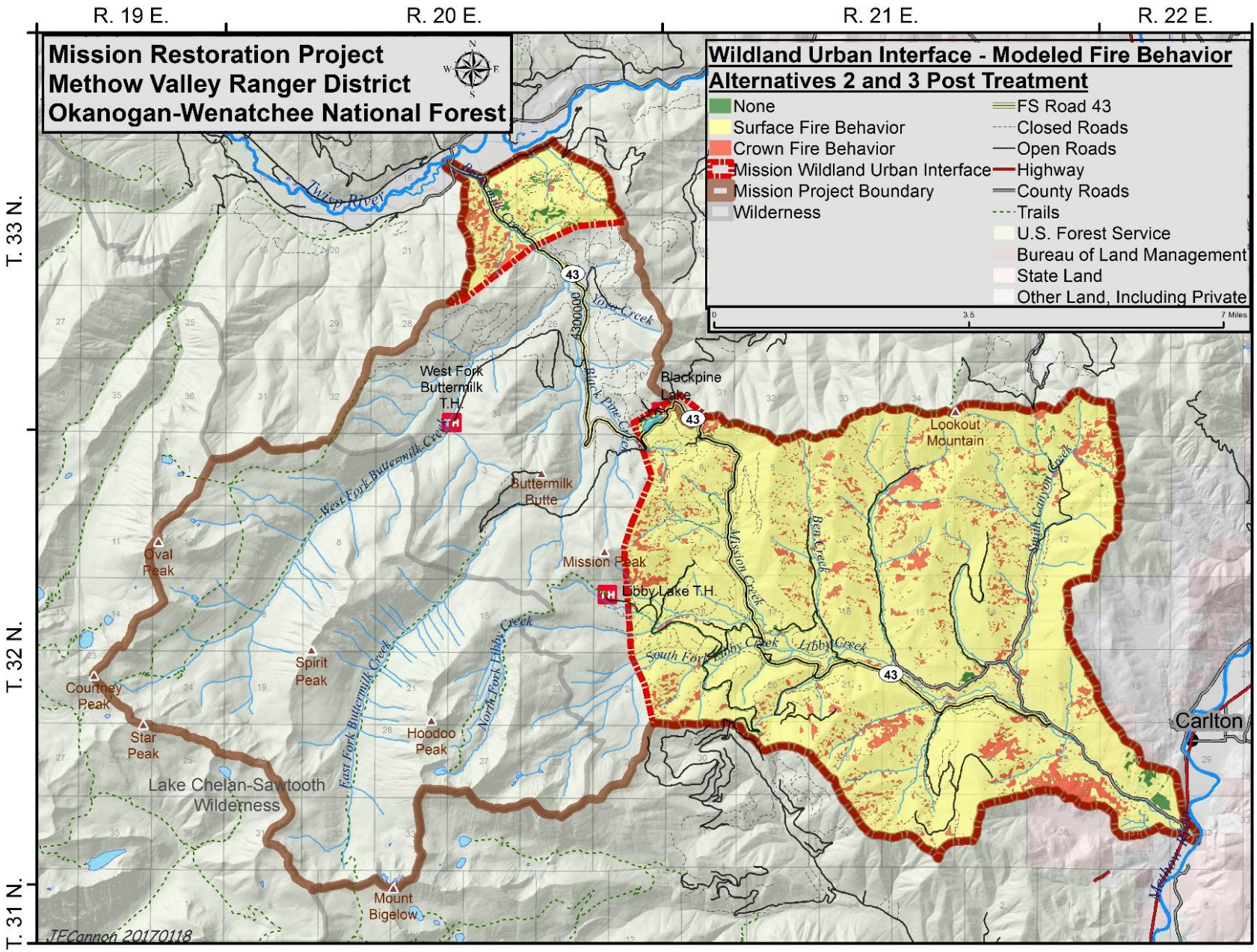
ResourceIndicator: Fire behavior in WUI

Proposed treatments in WUI would create beneficial, short-term, minor to moderate effects by reducing flame lengths and limiting crown fire behaviorbecause proposed thinning and prescribed fire treatments would have the impacts described in Figure 9 above. Under modeled conditions, the amount of area with low flame lengths would increase by 5%, the amount with moderate flame lengths would decrease by 3%, and areas with high or extreme flame lengths would decrease by 1% each. The amount of area with surface fire would increase by 6%. Reducing fire behavior in the WUI would increase the likelihood of successful direct suppression tactics by creating lower fire intensities that accompany reduced flame length and more limited crown fire behavior. Spotting potential would diminish because torching would be more limited. A reduction in flame lengths and crown fire behavior would help create a safer environment for firefighters and developments. Treatments would create a more open landscape where understory herbaceous vegetation would eventually grow, contributing to fuel loading. The flame lengths created by these fuels, however, would still be less than those created by torching trees. Openings in the tree canopy would allow for more successful use of retardant to limit fire spread. Where underburning is proposed, the initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would maintain lower surface fuel loading, scorch lower tree branches, and help sustain the open arrangement of understory trees to limit the potential for crown fire initiation. This would create a beneficial, long-term, minor to moderate effect by extending the impact of the first treatments.Figure 10 shows post-treatment fire behavior in the WUI under modeled conditions.

ResourceIndicator:Fire hazards along FS Roads 43 and 4340

Proposed treatments along FS Roads 43 and 4340 would create beneficial, short-term, minor to moderate effects by reducing flame lengths and limiting crown fire behavior because proposed thinning and prescribed fire treatments would have the effects described in Figure 9 above. Under modeled conditions, the amount of area with low flame lengths would increase by 7%, the amount with moderate flame lengths would decrease by 3%, the amount of area with high flame lengths would decrease by 1%, and extreme flame lengths would decrease in 3% of the area. The amount of area with surface fire would increase by 8%.Reducing fire behavior along these roads would increase the safety of those using them for ingress and egress, and provide for more successful direct suppression tactics by creating lower fire intensities that accompany reduced flame length and more limited crown fire behavior. Spotting potential would diminish because torching would be more limited. A reduction in flame lengths and crown fire behavior would help create a safer environment for firefighters and developments.

Figure 10:Post-treatment modeled fire behavior in the Wildland Urban Interface (WUI).



Treatments would create a more open landscape where understory herbaceous vegetation would eventually grow and contribute to fuel loading and increased flame lengths. The flame lengths created by these fuels, however, would still be less than those created by torching trees. Openings in the tree canopy would allow for more successful use of retardant to limit fire spread. Where underburning is proposed, the initial entry of thinning and underburning would be followed by a second underburning treatment within approximately 15 years that would maintain lower surface fuel loading, scorch lower tree branches, and help sustain the open arrangement of understory trees to limit the potential for crown fire initiation. These treatments would help create a fuelbreak with beneficial, long-term, minor to moderate effects by extending the impact of the first treatments. WUI treatments adjacent to private lands would be prioritized as funding became available. The effectiveness of these treatments would last approximately 10-15 years until surface fuels and vegetation accumulated enough to counteract the changes brought about by proposed treatments. At that time, further thinning and/or prescribed fire treatments would be necessary to extend the effectiveness of these fuelbreaks.

ResourceIndicator:FS Roads greater than 0.5 miles

Alternative 2 would have 11% fewer miles of roads greater than 0.5 miles on NFS lands than Alternative 1, resulting in adverse, long-term, minor impacts to access for vegetation and fire management. Most of the changes in road status between Alternatives 1 and 2 would be from open to closed, allowing for their continued use during emergency fire suppression or longer-range vegetation and fuels management activities. Decommissioning would occur on roads that access areas that are generally accessible from other roads, or on roads that access areas with limited forest management needs.

Cumulative Effects

Spatial and Temporal Context for Effects Analysis

The spatial boundary for analyzing the cumulative effects to the fire and fuels resource isthe project area boundary because it follows the natural geographical border of sub-watersheds that form the boundary of the area assessed for departure from the desired range of CFR. Wildfires within this area are the most likely to affect WUI and the use of FS Roads 43 and 4340. Roads within this area provide the only access to the project area for vegetation and fuels management and fire suppression.

The temporal boundaryfor analyzing the cumulative effects to amount and arrangement of CFR and wildfire hazards in WUIis15 years post-projectbecause after this point, surface fuels and understory vegetation changed by proposed treatments would accumulate to the point of contributing to increased CFR and wildfire hazards. Overstory thinning would have a longer effect on crown fire behavior (up to 30-50 years) depending on the length of time it took for understory trees to grow into the overstory; however, this time period will not be used as temporal boundary because surface fuels and understory vegetation changes that would affect fire behavior would occur 15 to 35 years before this period. The temporal boundary for analyzing the cumulative effects to access for vegetation and fuels managementis 30 years, the likely period of time until future management activities would occur after all treatments proposed in this project are completed.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

The cumulative effects of past management actions before 2011 on CFR have already been evaluated in this analysis because EMDS considered the type and arrangement of vegetation, surface fuel, species composition, stand structure, and other characteristics created by past thinning, prescribed burning, insect & disease outbreaks, wildfires, and grazing. Effects of wildfires in the project area have been considered in WUI hazard analysis by adjusting fuel models to account for changes when determining existing fire behavior. Past actions to close or decommission roads have helped create the existing condition. For these reasons, the analysis of past actions in this section is based on current environmental conditions.

There are no present or reasonably foreseeable actions within the spatial or temporal context for this effects analysis that would affect the amount or arrangement of crown fire risk, change fire behavior in WUI or along FS Roads 43 and 4340, or alter road access for vegetation and fire management. Some private landowners in the Libby Creek watershed may intend to reduce hazardous fuels around their homes to minimize wildfire hazards in WUI, but the location and timing of these plans are known. Considering the impacts of the proposed actions again in a cumulative effects analysis would repeat the existing condition analysis described above. Therefore, there are no cumulative effects to this resource element in Alternative 2.

Conclusion

Implementing the proposed thinning and prescribed fire treatments described above would cause beneficial, short term to long term, minor to moderate effects on maintaining or moving toward the desired range of crown fire behavior in the Buttermilk and Libby sub-watersheds. These treatments would cause beneficial, short-term, minor to moderate effects on reducing fire behavior in WUI and wildfire risks along FS Roads 43 and 4340. Alternative 2 would implement proposed changes in transportation access that would cause adverse, long term, minor impacts to road access for vegetation and fire management.

Alternative 3

Because the proposed thinning and prescribed fire treatments described for Alternative 2 are identical in Alternative 3, this section will only describe the effects of the Alternative 3 proposed transportation changes on access for vegetation and fire management.

Proposed Actions Dismissed from Further Consideration

The following proposed actions will not be considered further in this analysis because they would have no measurable effect on altering access for vegetation and fire management: soil restoration; rock armoring; replacing undersized culverts or installing fish culverts; beaver habitat or coarse woody debris enhancement; or creating hardened fords.

Effects

Figure 11 displays the values for the resource indicator that would result from Alternative 3.

Figure 11:Resource Indicator and Measure for Alternative 3.

Resource Element	Resource Indicator	Measure	Alternative 3
Access for vegetation and fire management	FS Roads in project area > 0.5 miles (99.3 miles total)	Percent of FS roads >0.5 miles long that would remain or be decommissioned post-project.	Remain: 69% Decommissioned:30%

Resource Indicator: Roads in project area

Alternative 3 would have 31% fewer miles of remaining roads that are greater than 0.5 miles than Alternative 1, resulting in adverse, long-term, moderate impacts to access for vegetation and fire management. Alternative 3 would have three times the amount of decommissioning compared to Alternative 2. The greatest impacts for vegetation and fire management would be approximately 2645 acres in areas accessed by the roads listed in Figure 12 below. Those noted as within “Designated WUI” lie within the CWPP WUI boundary in areas identified as areas with high risk to private lands.The loss of roads in these areas would limit the options available for vegetation management because, although roads could theoretically be built into these areas again in the future, it is highly unlikely that the amount of current roaded access would be recreated. Current limitations on the harvest technology and uneconomical alternatives such as helicopter or cable logging would further restrict opportunities to conduct treatments such as overstory thinning in future projects. Understory thinning and prescribed fire treatments may still occur in the future, but limited access would increase implementation costs and would increase safety hazards for personnel working in these areas. Fire suppression access in the areas listed below would require longer access times with more limited resources (in the case of ground-based resources) or would be more dependent on aerially delivered firefighters

Figure 12:Road Systems proposed for Decommissioning in Alternative 3.

FS Road System	Area Accessed	Designated WUI
4300145 4300146 4300150-1.22L-1	Hornet Ridge	Y
4300220	Forest south of Blackpine Meadows	N
4300550 4300553 4300555 4300556 4300560	West of West Fork Buttermilk Creek, Scaffold Ridge	N
4300615	Yoyo Creek/Shady Nook basin	N
4300645	Yoyo Creek/Shady Nook basin	N
4340700 4340785 4340788	West of Mission Creek	Y
4342300	Chicamun Canyon	Y

Cumulative Effects

Spatial and Temporal Context for Effects Analysis

The spatial boundary for analyzing the cumulative effects to access for fire and fuels resource is the project boundary because the roads within this boundary provide access for vegetation management and suppression access. Roads outside of the project area do not provide this access can cannot substitute for it.

The temporal boundary for analyzing the cumulative effects to access for vegetation and fuels managementis 30 years, the likely period of time until future entry would occur after all treatments proposed in this project are completed.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

There are no present or reasonably foreseeable actions within the spatial or temporal context for this effects analysis that would affect access for vegetation and fire management. Therefore, there are no cumulative effects to this resource element in Alternative 3.

Conclusion

Implementing proposed transportation system changes in this alternative would cause adverse, long-term, moderate impacts to access for vegetation and fire management.

Summary

If no action were taken in this project, restoration of desired ranges of CFR would experience adverse, long-term, minor to major impacts. Fire behavior in WUI and fire hazards along FS Roads 43 and 4340 would experience adverse, short-term to long-term, minor to moderate impacts. Road access for vegetation and fire management would experience beneficial, long-term, moderate impacts.

In either action alternative, proposed thinning and prescribed fire treatments would cause beneficial, short term to long term, minor to moderate effects on maintaining or moving toward the desired range of crown fire behavior in the Buttermilk and Libby sub-watersheds. These treatments would cause beneficial, short-term, minor to moderate effects on reducing fire behavior in WUI and wildfire risks along FS Roads 43 and 4340. Alternative 2 would implement proposed changes in transportation access that would cause adverse, long term, minor impacts to road access for vegetation and fire management. Alternative 3 would implement proposed changes in transportation access that would cause adverse, long term, moderate impacts to road access for vegetation and fire management.

Refer to Appendix C for Response to Intensity Factors for Determining Significance.

Compliance with LRMP and Other Relevant Laws, Regulations, Policies and Plans

Okanogan National Forest Land and Resource Management Plan

Implementing the proposed action would be consistent with the goals, objectives, and standards and guidelines of the Forest Plan as follows:

Forest-wide Standards and Guidelines:

MA 19-4: Prescribed fire would be used to meet Management Area goals.

MA 19-6: Fuels treatments would be designed to be cost-effective and consider fuel profiles, site-productivity, and other relevant objectives. Desired fuel profiles and treatments necessary to achieve this profile have been determined. Treatment methods have been selected based on analysis of long-term site-productivity considerations.

MA 19-7: Fuels treatments would help provide for retention or, in some areas, increase of large woody debris on the forest floor.

MA 19-8: Treatment of natural fuels shall be prohibited in identified old growth stands. This project seeks a Forest Plan Amendment for this standard because some Forest Plan Old Growth (FPOG) in dry forest locations is at risk of high-severity wildfire. An amendment would allow for treatments designed to retain and promote FPOG in a sustainable manner.

MA 19-9: Fuels treatments in stands managed as future old growth would provide for retention of key old growth components.

MA 20-1: site-preparation objectives would occur concurrently with fuels management objectives.

MA 20-26: Firewood availability would be considered in site preparation planning.

MA 20-49: Fuels treatments after precommercial and commercial thinning would minimize damage to residual stems. Post-treatment tree retention levels would be prescribed in fuels treatments.

Management Area 5 (Roaded Natural Recreation and Scenic Viewing, Retention or Partial Retention):

MA 5-19C: Prescribed fire would meet the visual quality objective within three years of application.

MA5-19C: Fuels treatment methods and locations would consider recreation, visual, and wildlife values.

Management Area 14 (Deer Winter Range – Wood Fiber Production):

MA 14-19C: Fuels would be treated to reduce the risk of wildfire to acceptable levels and further protect timber stands, wildlife values, and other resources from unacceptable losses caused by wildfire.

MA14-19D: Where cost-effective, fire-tolerant stands would be on a prescribed burning schedule.

Management Area 15B (unmodified primitive environment within designated wilderness):

MA 15B-19C: Planned ignitions are not proposed in wilderness.

MA15B-19D: Prescribed fire is not proposed in wilderness.

MA15B-19E: Prescribed fire is not proposed in wilderness.

Management Area 17 (Developed Recreation Opportunities):

MA17-19C: Fuels treatments would incorporate visual and recreation objectives and be designed to reduce or eliminate damaging wildfire effects to recreation resources.

Management Area 25 (Intensive Timber and Range Management):

MA25-19C: Fuels treatments would reduce risk of wildfire to acceptable levels while maintaining long-term site productivity.

MA25-19D:Fuels would be treated to reduce the risk of wildfire to acceptable levels and further protect timber stands, wildlife values, and other resources from unacceptable losses caused by wildfire.

MA25-19E: Where cost-effective, fire-tolerant stands would be on a prescribed burning schedule.

Management Area 26(Deer Winter Range, Modified Recreation):

MA26-19C:Fuels treatments would provide for the retention and/or enhancement of key wildlife habitat wherever practicable.

Northwest Forest Plan

Riparian Reserves:

FM-1:Fuels treatments would help attain Riparian Management Objectives by increasing the resilience of RRs to disturbance by wildfire while minimizing disturbance of riparian ground cover and vegetation. Treatment strategies have been developed with recognition of the role of fire in ecosystem function and identify instances where fuels management activities could damage long-term ecosystem function.

FM-4: Prescribed burn projects and prescriptions would be designed to contribute to attainment of Aquatic Conservation Strategy objectives.

FM-5: If Riparian Reserves are significantly damaged by prescribed burning outside prescribed parameters, a review by district aquatic, soil, and/or hydrology staff would occur to determine whether adverse effects occurred and what, if any, rehabilitation treatment would be needed to attain Aquatic Conservation Strategy objectives, and what that treatment plan would entail.

Other: In Riparian Reserves, water drafting sites would be located and managed to minimize adverse effects on riparian habitat and water quality, as consistent with Aquatic Conservation Strategy objectives.

Late-Successional Reserves:

Fuels management in LSRs will use minimum impact suppression methods in accordance with guidelines forreducing risks of large-scale disturbances.

Matrix:

Fuels management activities were developed based on input from local governments, agencies, and landowners as well as input from watershed analyses and considered factors that may affect hazard reduction goals.

Forest Service Manual Direction

FSM 5103.2 Ecological

This project identified and used fire ecology to frame land and resource management objectives.Fire Management programs and activities would be used to implement LRMP objectives.Public health and environmental quality considerations have been factored into proposed activities. Proposed treatments would provide for a landscape that is more resilient to disturbance in accordance with management objectives

FSM 5140.3 Policy

Proposed treatments would implement a hazardous fuels management and prescribed fire program applying principles and policy elements to restore resilient landscapes described in FSM 5103 and Wildland Fire Doctrine (FSM 5131); principles from the Cohesive Strategy (A National Cohesive Wildland Fire Management Strategy Phase II National Report, May 2012) (Wildland Fire Leadership Council; 2012); and guidelines from the Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide (NWCG 2014).

FSM 5141 Hazardous Fuels Management and Prescribed Fire Planning

Proposed hazardous fuels management and prescribed fire treatments have been developed in compliance with the LRMP to meet resource management objectives. Resource objectives for specific hazardous fuels management and prescribed fire projects were derived from the NEPA analysis. The entire project area has been analyzed under NEPA. The NEPA analysis document identifies objectives and analyzes the effects of hazardous fuels management and prescribed fire projects.

FSM 5142.3 – Prescribed Fire Policy

Proposed prescribed fire treatments would be used in a safe, carefully planned, and cost-effective manner to achieve desired conditions and attain management objectives identified in the LRMP. Prescribed fire plans, including wildfire declarations, will use the Interagency Prescribed Fire Planning and Implementation Procedures Guide. Weather conditions would be monitored during all phases (including mop-up) of prescribed fire implementation. Long-term weather conditions such as drought would be considered in all phases of prescribed fire planning and implementation. Unless the authorizing official makes an exemption, a project-specific spot weather forecast would be obtained

prior to ignition; for each day that ignition continues; on any day the fire is actively spreading; or when conditions adversely affecting the prescribed fire are predicted in the general forecast.

Watershed Analyses

Recommendations from watershed analyses that have been considered in this project includeconsidering landowners input in implementing prescribed fire in the watershed; proposing treatments in Libby Creek to minimize the potential for high-severity fires to degrade large areas and destroy habitat for threatened or endangered fish species; proposing treatments in Libby Creek that utilize thinning, underburning, and mistletoe sanitation to maintain stand health and minimize potential for stand-replacing fires; and focusing proposed thinning and prescribed burning treatments in WUI to minimize the risk of fire spread between NFS and private lands, especially in Smith Canyon, Elderberry Canyon, Chicamun Canyon, and Lower Libby Creek.

Federal Wildland Fire Management Policy

This analysis recognizes wildland fire as an essential ecological process. Proposed activities focus on reducing hazardous fuels and restoring fire-adapted ecosystems and used planning and decision analysis processes that address current and anticipated conditions.

Okanogan-Wenatchee Forest Restoration Strategy

The Restoration Strategy was used to analyze conditions in the Mission project area and develop possible treatment options to respond to findings. Proposed treatments would maintain forested landscapes in the desired range, or help move them toward this range.

Spruce Budworm Assessment

Recommendations from this document that have been considered in this project include focusing silvicultural and prescribed fire treatments in the dry-cover types to reduce susceptibility to western spruce budworm and reduce risk of uncharacteristic crown fires; and implementing a fuelbreak and road treatment strategy to provide additional time for silvicultural and fuels treatments to occur.

Okanogan County Community Wildfire Protection Plan

This project proposes treatments to reduce wildfire risks in the WUI and specifically within the two CWPP priority treatment areas that lie within the project boundary

National Roadmap for Responding to Climate Change

This analysis is consistent with the guidance for National Forests to adapt and prepare for changing climates, with a management emphasis on restoring the functions and processes characteristic of healthy, resilient ecosystems through adaptive restoration. Proposed restoration treatments in this project would also improve the ability of ecosystems to withstand the stresses and uncertainties associated with climate change.Proposed thinning treatments are aligned with those suggested to promote resistance, resilience, and response to climate change as synthesized in *Responding to Climate Change in National Forests: a Guidebook for Developing Adaptation Options* (Peterson et al., 2011).

Degree to Which the Purpose and Need for Action is Met

Figure 13 summarizes the effects of each alternative analyzed for this project.

Figure 13:Summary comparison of how the alternatives address the Purpose and Need.

Purpose and Need	Indicator/Measure	Alt 1	Alt 2	Alt 3
P&N #1 P&N #3 P&N #4	**The amount and arrangement of each type of crown fire risk in the Buttermilk Creek watershed as compared to the desired range of variability.**			
	The percentage of Buttermilk Creek of Low, Moderate, and High CFR.	Low CFR: Below desired range Moderate CFR: Within desired range High CFR: Above desired range	Low CFR: Below desired range, but moved closer to it Moderate CFR: Remains within desired range High CFR: Above desired range, but moved closer to it	Same as Alt 2
	The average patch size of each CFR level in Buttermilk Creek.	Low CFR: Below desired range Moderate CFR: Below desired range High CFR: Within desired range	Low CFR: Below desired range, but moved closer to it Moderate CFR: Below desired range, and moved further away from it High CFR: Remains within desired range	

Purpose and Need	Indicator/Measure	Alt 1	Alt 2	Alt 3
	The amount and arrangement of each type of crown fire risk in the Libby Creek watershed as compared to the desired range of variability. The percentage of Libby Creek at Low, Moderate, and High CFR. The average patch size of each CFR level in Libby Creek.	Low CFR: Within desired range Moderate CFR: Within desired range High CFR: Within desired range Low CFR: Below desired range Moderate CFR: Below desired range High CFR: Within desired range	Low CFR: Remains within desired range Moderate CFR: Remains within desired range High CFR: Remains within desired range Low CFR: Remains within desired range Moderate CFR: Below desired range, and moved further away from it High CFR: Remains within desired range	Same as Alt 2:
P&N #6	**Fire behavior in WUI (23,000 acres):** Percent of flame length by size class Percent of fire behavior by type	Low: 52% Moderate:35% High: 4% Extreme: 9% None: 3% Surface: 82% Crown: 15%	Low: 57% Moderate: 32% High: 3% Extreme: 8% None: 3% Surface: 88% Crown: 9%	Same as Alt 2

Purpose and Need	Indicator/Measure	Alt 1	Alt 2	Alt 3
	Fire behavior along FS Roads 43 and 4340 (701 acres total) Percent of flame length by size class	Low: 85% Moderate: 9% High: 2% Extreme: 4%	Low: 92% Moderate: 6% High: 1% Extreme: 1%	Same as Alt 2
	Percent of fire behavior by type	None: 28% Surface: 61% Crown: 11%	None: 28% Surface: 69% Crown: 4%	
P&N #7	**Access for vegetation and fire management (99.3 miles total)** Percentof FS roads >0.5 miles that would remain or be decommissioned post-project.	Remain: 100% Decommissioned: 0%	Remain: 89% Decommissioned:11%	Remain: 69% Decommissioned:30%

Appendix A: Summary of FlamMap Weather Variables

Mission Restoration Fire Behavior Modeling with FlamMap

Base Landscape Data used for FLAMMAP lcp file:

- Source: Landfire 2012
- Landscape edits: Since 2012, the only disturbance of note in the project area was the 2014 Carlton Complex wildfire. I obtained Soil Burn Severity spatial data and used this as a surrogate to determine changes to fuel models and canopy cover. Based on field verification using this data from this fire in the South Summit area, we determined that SBS of Moderate or High were found in areas with 75% or more mortality and > 90% surface fuel consumption. Where these areas existed in the Mission Project area, Canopy Cover was changed to 0 and Fuel Model was changed to 102 (low load, dry climate grass) to account for the growth of grass in open areas post-fire. An SBS of Low correlates to areas with little or no overstory mortality, and patchy surface fuel consumption. Where this existed in the Mission project area, no changes were made to Canopy Cover because it is unlikely that any mortality occurred; FM 165 (very high load dry climate timber-shrub) was changed to FM 161 (low load dry climate timber-grass-shrub) to account for the consumption of most shrubs in the understory and the growth of grass post-fire.
- Fuel Moistures: weather data from Douglas Ingram Ridge RAWS (DIR RAWS) and Leecher Mtn RAWS were used for this analysis because they are the closest RAWS to the project area. DIR RAWS is on a south/southeast aspect and likely experiences hotter and drier conditions than much of the Buttermilk Cr drainage in the project area. Leecher RAWS is on a ridge-top and more exposed to higher-elevation winds and drying effects. FireFamily Plus was used to determine 90th percentile fuel moistures from each of these RAWS to determine if the variation between each. The wetter fuel moistures were used in this analysis as a baseline to model conditions. Figure 14 lists fuel moistures from these RAWS and those used in the analysis.

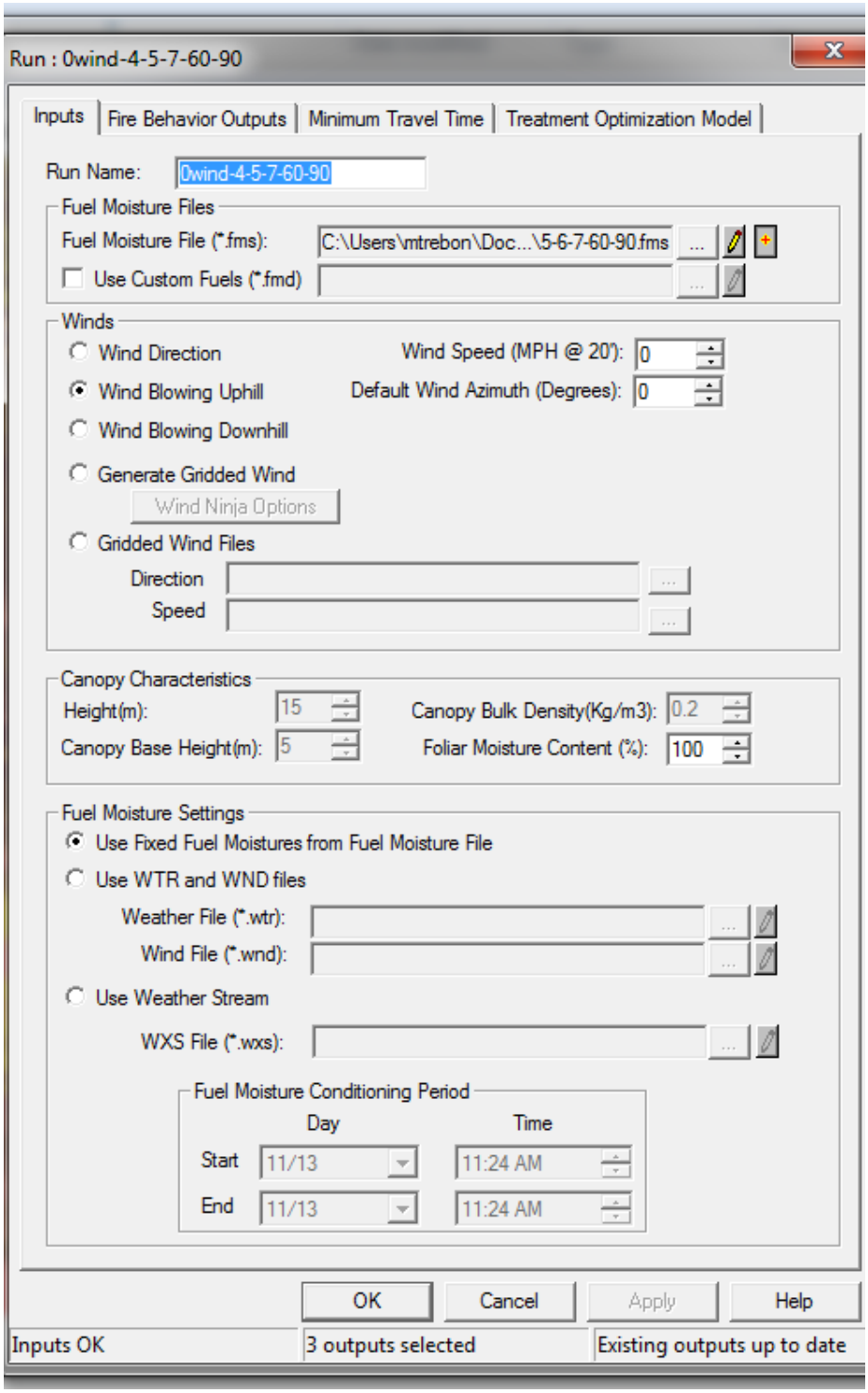
Figure 14:Fuel moistures by fuel size from local RAWS and used in analysis.

Fuel Size	DIR RAWS	Leecher RAWS	Used in Analysis
1-hour	3%	4%	4%
10-hour	4%	5%	5%
100-hour	6%	7%	7%
Herbaceous	33%	40%	60%
Live Woody	63%	69%	90%

- Winds: To determine baseline conditions without the effect of wind, Flammap was run with 0 mph windspeed. The outcome of this modeling run is used in the assessment of fire behavior.

Figure 15 below shows a screen shot of the Flammap modeling run used for this analysis to determine existing and post-treatment fire behavior in the WUI.

Figure 15:FlamMap Criteria for Modeling Fire Behavior on Base and Post-Treatment Landscapes.



Appendix B: Literature

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Appendix C: Response to Intensity Factors for Determining Significance (FSH 1909.15_10)

In this analysis, these factors are addressed regarding proposed thinning and prescribed burning activities.

1. *Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.*

   If no action were taken in this project, restoration of desired ranges of CFR would experience adverse, long-term, minor to major impacts. Fire behavior in WUI and fire hazards along FS Roads 43 and 4340 would experience adverse, short-term to long-term, minor to moderate impacts. Road access for vegetation and fire management would experience beneficial, long-term, moderate impacts.

   In either action alternative, proposed thinning and prescribed fire treatments would cause beneficial, short term to long term, minor to moderate effects on maintaining or moving toward the desired range of crown fire behavior in the Buttermilk and Libby sub-watersheds. These treatments would cause beneficial, short-term, minor to moderate effects on reducing fire behavior in WUI and wildfire risks along FS Roads 43 and 4340. Alternative 2 would implement proposed changes in transportation access that would cause adverse, long term, minor impacts to road access for vegetation and fire management. Alternative 3 would implement proposed changes in transportation access that would cause adverse, long term, moderate impacts to road access for vegetation and fire management.

   There would be no cumulative effects caused by this project.

2. *The degree to which the proposed action affects public health or safety.*

   Thinning proposed in this project will not affect public health or safety. The potential for a prescribed fire to escape unit boundaries are low and would be addressed on a unit-by-unit basis using standard, mandatory procedures including fire behavior modeling that considers likelihood and direction of potential escape, expected fire behavior outside unit boundaries, and determines personnel and equipment needed to maintain fire within the burn unit. Providing for sufficient staffing and implementation of control techniques would be a priority, and may include creating fireline, installing hose lays, pre-wetting fuels, establishing portable tanks, regular patrols, and mopping-up during main ignition and post-burn to monitor and eliminate the risk to public safety from escaped fires. Prescribed burning would affect air quality, which is discussed in the air quality resource report (Trebon 2016a).

3. *Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.*

Thinning proposed in this project would not negatively affect unique characteristic of the geographic area. Prescribed burning near wetlands would follow design criteria to prevent negative impacts to these features. No cultural resources lie within proposed treatment units. No park lands, prime farmlands, wild and scenic rivers, or ecologically critical areas lie in the project area.

4. *The degree to which the effects on the quality of the human environment are likely to be highly controversial.*

   The effects of proposed thinning and prescribed burning treatments on the quality of the human environment may cause controversy among people with differing viewpoints. The degree of controversy that may occur is unknown.

5. *The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.*

   The effects of thinning and prescribed burning on the human environment are well-researched and predictable through models and decades of past similar practices.

6. *The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.*

   Thinning and prescribed fire actions proposed in this project would not set a precedent for future actions with significant effects, or represent a decision in principle about a future consideration.

7. *Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.*

   Thinning and prescribed fire activities proposed in this project would not be related to other actions and would not contribute to cumulatively significant impacts on the environment.

8. *The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.*

   Thinning and prescribed fire activities would not affect districts, sites, highways, structures, or objects listed in or eligible for listing in the NRHP, or cause loss or destruction of significant scientific, cultural, or historical resources.

9. *The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.*

Thinning and prescribed fire activities would not adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the ESA.

10. *Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment. (40 CFR 1508.27)*

    Thinning and prescribed fire activities would not threaten a violation of any Federal, State, or local law or requirements imposed for the protection of the environment.